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Optimal Hedging Levels and Hedging Effectiveness in Cattle Feeding

By Richard G. Heifner

Optimal hedging level, minimum-risk hedging level, and hedging effectiveness are defined in a manner consistent with portfolio theory and used to analyze hedging potential in cattle feeding. Estimated upper limits on optimal hedging levels ranged from 0.56 to 0.88 unit of short futures per unit of four types of slaughter cattle produced at five locations. When futures trading costs are taken into account, optimal hedging levels are depressed below these limits, depending upon the resource availabilities and profit expectations of individual firms. Location, grade, and sex of the cattle fed have small effects on optimal hedging levels and hedging effectiveness.

Key words: Futures trading; hedging; cattle feeding; risk; price analysis.

Within the last decade, the introduction and growth of active trading in live cattle futures has opened new hedging opportunities for cattle feeders. The hedging of inventories in commodity futures contracts is a well-established business practice, having been employed by grain merchants in the Midwest at least since the 1870's. But experience in trading cattle futures has been limited and the desirability of hedging remains subject to question—particularly among feeders who are not in position to deliver on the contract.

Cattle feeders have had a hedging market available in the Chicago Mercantile Exchange live beef cattle futures contract since November 30, 1964. Contracts are traded for delivery every second month beginning in February. The contract calls for delivery of Choice Grade steers weighing 1,050 to 1,250 pounds, but provision is made for substituting a limited number of high Good Grade steers at appropriate discounts. With the August 1969 future, the contract size was changed from 25,000 to 40,000 pounds. Par delivery was at Chicago until the August 1971 contract, with alternative delivery points at Omaha and Kansas City at discounts of 75¢ and $1 per hundredweight, respectively. For the August 1971 contract and subsequent contracts, par delivery is at Omaha with allowances at alternative delivery points as follows: Chicago, +50¢; Peoria, +50¢; Guymon, Okla., −$1.

Substantial numbers of feedlot cattle are hedged, but these represent a small fraction of the cattle on feed in the United States. The average number of open contracts in live beef futures was 13,638 during 1970-71 (*33*, p. 7).[1] With the change in contract size, this represented almost as many cattle as did open positions during the peak trading year, 1968-69. However, not all of the short open positions represent hedging. In a survey conducted on May 29, 1969, the Commodity Exchange Authority (*34*, p. 35) found about half of the total short positions classified as hedging. The 13,049 short hedging positions reported would have covered less than 5 percent of the over 11 million head of cattle on feed reported for April 1, 1969 (*38*, p. 6).

Economic theory suggests at least two types of benefits that may arise through futures trading. First, futures trading provides for shifting risks from production and marketing specialists to others who are willing to bear the risks at lower costs.[2] In this respect, it serves as an alternative to other types of capital markets such as the stock market or contracting.

Another type of benefit arises when the forward prices generated by futures trading enable producers and marketing firms to better coordinate their expectations and plans. This can result in an improved allocation of production resources over time. In this function, futures trading serves as an alternative or supplement to other coordinating arrangements such as integration through ownership, cooperatives, marketing orders and agreements, and Government control.[3]

This study focuses upon the risk-shifting aspect of futures trading. Its purpose was to measure the potential for hedging as a means for shifting the price risks associated with cattle feeding. To this end, the concepts of optimal hedging level, minimum risk hedging level, and hedging effectiveness are defined within the general framework for decisionmaking under risk that is provided by portfolio theory. Estimates of minimum risk hedging levels and hedging effectiveness for four types of

Footnotes are at end of article, p. 35.

cattle in five major cattle feeding regions are presented. Finally, the impact of futures trading costs and hedgers' profit expectations on optimal hedging levels is examined.

The Importance of Risk Aversion

If futures trading is to result in improved distribution of risk, this benefit must be reflected in gains or potential gains to individual traders. Otherwise, individuals would have no motivation to use futures markets. For cattle feeders, as for other traders, the motives for trading in futures include making profits and reducing risk. By making profits, we mean obtaining long-run average returns which exceed costs. Reducing risk involves reducing profit variability, i.e., increasing profit stability. Businessmen buy insurance and hold liquidity reserves, and bankers require their borrowers to hold prescribed levels of equity, because risk is a factor in most business operations. Cattle feeding is no exception.[4]

Early students of futures trading concentrated on the risk-shifting aspects of hedging using several different measures of risk. For example, in his studies of the protection afforded by hedging, Howell employed tabular comparisons of the distribution of cash price changes and the distribution of basis changes.[5] Graf (*8*) measured hedging effectiveness in terms of percentage reduction in the gain or loss for holding grain stocks over selected intervals.

Emphasis was diverted from the risk-shifting aspect of hedging when Working (*40*) concluded that much hedging could not be explained simply as risk avoidance. He introduced a multipurpose concept of hedging and listed a variety of hedging categories. Taking note of Working's argument, Gray (*9*) proposed that lack of price bias be used as a criterion of hedging effectiveness.[6]

Recent students of futures trading have been concerned with the effect of hedging on both risk and expected return. D'Arge and Tomek (*4*) compared mean incomes and standard deviations of incomes for Long Island potato producers using various hedging and marketing strategies. Heifner (*15*) analyzed the impact of hedging on the mean and variance of returns from grain storage. Tomek and Gray (*32*) studied the effectiveness of hedging in reducing the variance of income from crop production and Gum and Wildermuth (*11*) have measured the effect of hedging in reducing price variability in cattle feeding.[7]

Modern developments in the general theory of risk bearing provide a framework for analyzing hedging decisions that simultaneously takes into account risk and expected return. The newer approach has its roots in the portfolio theory of Markowitz (*25*) and Tobin (*31*). Johnson (*22*) demonstrated how futures trading can be viewed as a problem of balancing risk against expected return. Ward and Fletcher (*39*) extended Johnson's theoretical framework to various special cases in hedging. In a previous article (*14*), I demonstrated application of the portfolio approach in managing seasonal grain inventories and Helmuth (*18*) has applied the approach to speculation in soybeans.

The Optimal Hedge

When we examine hedging in the context of portfolio analysis, we must conclude that the traditional illustration of hedging by holding one unit of the futures position for each unit of cash position can be misleading. This view of hedging is strictly applicable only when cash profits and futures profits are perfectly correlated. The portfolio approach provides a procedure for determining optimal hedging levels when this restrictive assumption is violated. It rests on the assumption that traders maximize expected profits relative to risk, or equivalently, minimize risk relative to expected profit, thereby avoiding arbitrary distinctions between hedgers and speculators. Furthermore, it leads to conclusions about hedging policies that are of considerable generality.

Like other problems of decisionmaking under risk, the hedging problem can be described as a problem of setting levels for activities with uncertain rates of return. In the hedging problem, the activities include cash activities and futures activities. The cash activities may involve holding a commodity in inventory over a prescribed time period or the transformation of one or more commodities into another commodity over time. The futures activities involve holding a long or short position in a specific futures contract over a designated period.

Let

$$R = \sum_k x_k r_k \tag{1}$$

be the total profit obtained by the firm in a particular time period where

x_k = level of activity k, a constant set by the decisionmaker, and

r_k = profit per unit of activity k, a random variable with mean μ_k, variance σ_{kk}, and covariances σ_{kh} for $h = 1,2,\ldots,n$.

Profit, r_k, is defined to equal revenue minus variable costs minus economic rents. Rents are imputed through the production process to those fixed resources which are limiting for the firm. In the absence of limiting resources, profit equals revenue minus variable costs.

For a particular activity, the mean profit rate, μ_k, may be viewed as having two components, a market rate of return for bearing risk and a residual return to the nonlimiting resources of the firm. In long-run competitive equilibrium, profit would approach the market return for bearing risk and, therefore, be the same for all firms. In the short run, profit includes not only the market return for risk bearing but also a return on the firm's fixed resources which are not limiting. It is in this short-run situation when the firm has nonlimiting resources committed to production where hedging becomes important.

We shall assume that the hedger seeks the best possible combination of expected total profit and variance of total profit.[8] Mathematically, this may be described as a problem in maximizing

$$(2) \qquad \psi = \sum_k x_k \mu_k - \lambda \sum_k \sum_h x_k x_h \sigma_{kh}$$

where λ is an unknown weight assigned to the variance of total profit relative to mean profit. In general, λ may differ from individual to individual depending upon differences in the degree of risk aversion among individuals.

Without knowledge of λ, direct maximization of ψ is impossible. However, in the hedging problem we are primarily concerned with the optimal level of the futures position relative to the cash position. We shall see that knowledge of λ is not required in order to determine the relative levels of the various activities that will prevail when ψ is maximized.[9]

When ψ is at a maximum, the partial derivatives of ψ with respect to the levels of the activities will be zero, i.e.,

$$(3) \quad \frac{\partial \psi}{\partial x_k} = \mu_k - 2\lambda \sum_h x_h \sigma_{kh} = 0 \qquad k = 1,2,\ldots,n$$

Let x_1 represent the level of the futures position and let x_2 represent the level of the cash position. Combining the first two equations in (3) and eliminating λ we obtain

$$(4) \quad x_1 = \frac{(\mu_1 \sigma_{22} - \mu_2 \sigma_{12}) x_2 + \sum_{h>2} (\mu_1 \sigma_{2h} - \mu_2 \sigma_{1h}) x_h}{(\mu_2 \sigma_{11} - \mu_1 \sigma_{12})}$$

Equation (4) provides a general condition for specifying the optimal level of the futures position given the levels of the other activities of the firm.

The absence of λ in equation (4) shows that the optimal level of the futures position is independent of the degree of risk aversion, so long as the levels of the other activities and the means, variances, and covariances of their profits remain constant. Thus, the optimal hedging level is the same for all risk-averse firms with the same mix of production activities and the same set of profit expectations and profit variances and covariances regardless of their differences in degree of risk aversion. Consequently, a single estimate of the optimal hedging level applies to a group of similar firms.

The second term in the numerator of equation (4) introduces the effects of other activities of the firm on the optimal level of hedging. Because the mix of production activities differs from firm to firm, the exact solution to equation (4) is specific to each individual firm. However, the second term vanishes if profits on the other activities are uncorrelated with profits on activities 1 and 2. This situation is approached for the cattle-feeding specialist who has no other production activities and for the feeder whose other activities, such as crop production, produce profits which are not highly correlated with cattle-feeding profits. In the empirical portions of this study, we assume that the effects of other activities on optimal hedging levels are negligible. Under this assumption, equation (4) reduces to the following expression for the optimal ratio of the futures position to the cash position:

$$(5) \qquad \frac{x_1}{x_2} = \frac{\mu_1 \sigma_{22} - \mu_2 \sigma_{12}}{\mu_2 \sigma_{11} - \mu_1 \sigma_{12}}$$

Optimal Hedging Levels for 2 Types of Feeders

Cattle feeders can be divided between those that have fixed resources committed to cattle feeding and those that have no such fixed commitments. In the former category are individuals who own feedlot facilities or possess cattle-feeding skills which are not readily marketable. In the latter category are individuals who hire custom feeding services.

Optimal futures trading strategies differ markedly between the two types of individuals. Equations (4) and (5) apply to both types, but the value of μ_2, the expected profit from cattle feeding, differs between the two groups. The expected cash profit, μ_2, includes returns to fixed resources so long as these resources are not limiting. Hence, it tends to be larger for the feedlot owner feeding his own cattle than for the custom feeder

who must subtract the costs of feeding services in determining profits.

For the custom feeder, virtually all costs are subtracted from returns and μ_2 tends to approach the market price for risk bearing. To the extent that the price risk in custom feeding is the same as the risk in holding a futures contract, competition would tend to force μ_1 and μ_2 to approach equality and the ratio x_1/x_2 would tend to approach 1. However, if at the same time the correlation between cash profits and futures profits approaches unity, the optimal hedging level becomes indeterminate. The data available and the methods used in this study do not permit sufficiently accurate estimates of these parameters to justify any conclusions about optimal futures positions as this situation is approached. Consequently, this study has little to say about futures trading for the custom feeder.

For the individual with fixed resources in cattle feeding, μ_2 may exceed the competitive rate of return for risk bearing. In contrast, the expected futures profit, μ_1, includes only the market return for risk bearing minus futures trading costs. This market return for risk bearing is commonly called a risk premium. Since both the risk premium and futures trading costs tend to be small, μ_2 tends to dominate and the solution to equation (5) tends to be negative, implying a short position in futures. This is the situation with which we are concerned.

The empirical results derived in this study are strictly applicable to the feeder who has resources in cattle feeding which are not used to full capacity. If all of his feeding resources are used to full capacity, his optimal futures position lies somewhere between the position that would be optimal for the feeder with excess capacity and the position that would be optimal for the custom feeder. In this sense, the estimates presented represent upper limits on the optimal short futures positions for cattle feeders.

The Minimum-Risk Hedge

The condition for the optimal hedge can be simplified if the market rate of return for risk bearing is zero and if futures trading costs are negligible. Under these assumptions, the profit rate on the futures activity, μ_1, is zero and equation (5) reduces to

$$x_1/x_2 = -(\sigma_{12}/\sigma_{11}) \tag{6}$$

Equation (6) also defines the hedging ratio that minimizes risk given the level of the cash activity. This can be shown as follows: The variance of total profit for activities 1 and 2 is

$$V = x_1^2\sigma_{11} + 2x_1x_2\sigma_{12} + x_2^2\sigma_{22} \tag{7}$$

Differentiating with respect to x_1 we obtain

$$\frac{\partial V}{\partial x_1} = 2x_1\sigma_{11} + 2x_2\sigma_{12} \tag{8}$$

Noting that the second derivative is positive, indicating a minimum, we set (8) equal to zero and find that it reduces to equation (6). The hedging ratio specified by equation (6) will be referred to as the minimum-risk hedge. It is also the optimal hedge when the expected costs or returns from hedging are zero and profits from other activities are uncorrelated with profits from activities 1 and 2.

To estimate the minimum-risk hedge, the sample ratio of the covariance and variance, s_{12}/s_{11}, may be employed where these are calculated individually by the standard formulas. This is exactly equivalent to the standard procedure that one would use for calculating the regression of unit cash profits on unit futures profits. Therefore, the standard least-squares regression algorithm provides a convenient means to approximate the minimum-risk hedge.

Unfortunately, as is the case for many ratio estimates, the properties of s_{12}/s_{11} as an estimator of σ_{12}/σ_{11} are not easily specified. The estimate is consistent but apparently biased in small samples. Examination of the first few terms of the Taylor expansion of s_{12}/s_{11} suggests that, when profits are from a bivariate normal distribution, the bias is positive and small with an upper limit of approximately 0.12 for the size of sample used here.[10]

Hedging Effectiveness

Following Johnson (*22*, p. 144) we can define a measure of hedging effectiveness as the proportional reduction in profit variance obtained through hedging. Let $H = x_1/x_2$ represent the size of the futures position relative to the cash position. Assuming once again that the cash and futures profits are uncorrelated with profits from other activities, hedging effectiveness is represented as

$$Z = 1 - (\sigma_{22} + 2H\sigma_{12} + H^2\sigma_{11})/\sigma_{22} \tag{9}$$

This simplifies to

$$Z = -(2H\sigma_{12} + H^2\sigma_{11})/\sigma_{22} \tag{10}$$

With complete hedging, $H = -1$, we have

(11) $$Z_c = (2\sigma_{12} - \sigma_{11})/\sigma_{22}$$

In this case, we note that hedging effectiveness exceeds zero, i.e., hedging reduces risk, if and only if the numerator is positive, i.e., if and only if

(12) $$\sigma_{12}/\sigma_{11} > 0.5$$

The term on the left is identical to the negative of the minimum-risk hedge as shown in equation (6).

The effectiveness of the minimum-risk hedge is

(13) $$Z_m = -[2(-\sigma_{12}/\sigma_{11})\sigma_{12} + (-\sigma_{12}/\sigma_{11})^2\sigma_{11}]/\sigma_{22}$$

This reduces to

(14) $$Z_m = (\sigma_{12})^2/(\sigma_{11}\sigma_{22})$$

which is the square of the correlation between cash profits and futures profits. Thus, the r^2 between cash profits and futures profits measures the effectiveness of the minimum-risk hedge.

As we depart from the assumption of zero hedging costs under which the minimum-risk hedge is optimal, the notion of hedging effectiveness loses its usefulness. The minimum-risk hedge is the most effective hedge possible in that it minimizes the variance of total profit relative to the variance of cash profit. Thus, where they differ, the optimal hedge is less effective than the minimum-risk hedge. This situation arises because the definition of hedging effectiveness disregards expected losses or expected profits on the futures position.[11]

Data Sources and Assumptions

Determination of optimal or minimum-risk hedging levels requires estimates of the variances and covariances of profits for the individual production and futures holding activities. The major source of profit variability in cattle feeding is the variation in prices of cattle and feed.[12] In this study, the variances and covariances in prices for feeder cattle, slaughter cattle, grain, and hay are taken into account. Prices on other inputs such as interest on borrowed capital, trucking, veterinary expense, etc., are assumed to be constant. Therefore, they do not enter into the calculation of the variances and covariances of profit.

The analysis is based upon profit observations for 18 consecutive 4-month feeding periods beginning in March 1965 and ending in March 1971. Profit from cattle feeding for each period is calculated by subtracting variable costs from returns. Costs include the value of the feeder, the grain, and the roughage priced at the beginning of the feeding period. Returns equal the value of the finished animal priced at the end of the feeding period. Risk is measured as the variance of profit after adjustment for seasonality. The adjustment for seasonality is accomplished by performing the calculations using a regression program and inserting dummy variables for two of the three seasonal feeding periods.

Table 1 lists the cattle-feeding locations analyzed. These were selected to represent the major cattle-feeding

Table 1.—Cattle and feed pricing points for the cattle feeding locations analyzed

Feeding location	Slaughter cattle market	Feeder cattle market	Grain market	Hay price [a]
Eastern Corn Belt	Chicago	Kansas City	Corn, Chicago	Illinois
Western Corn Belt	Omaha	Omaha	Corn, Omaha	Iowa
Colorado	Denver, direct	Amarillo, auction	Corn, Denver	Colorado
High Plains	Clovis, N.Mex., direct	Clovis, N.Mex., auction	Sorghum, Ft. Worth	New Mexico
California	Visalia, direct	Visalia, auction	Barley, Stockton Sorghum, Los Angeles	California

[a] Hay prices are State averages as reported in Agricultural Prices (*36*).

regions in the United States and to take advantage of price data collected by Livestock Market News. Shown on the table for each location are the markets used as sources of price quotations for slaughter cattle, feeder cattle, grain, and hay.

To avoid confusing differences due to location with differences due to type of cattle, the same weight, sex, and grade categories were analyzed for each location so far as possible. Previous studies (*2, 3, 5, 12*) suggest that short-fed Good and Choice steers and heifers are among the most numerous types of fed cattle produced in each of the regions. Good Grade feeder cattle were assumed to finish out to Good Grade slaughter cattle and Choice feeders were assumed to finish as Choice slaughter cattle. Feed requirements, costs and rates of gain are assumed to be the same for Good Grade cattle as for Choice Grade cattle. The assumptions about buying and selling weights and feed consumption are shown in table 2.

Buying prices for feeders and selling prices for slaughter cattle are weekly averages reported by USDA's Market News Service for the markets selected.[13] These are calculated by Market News Service as a simple average of the daily prices for each week. The weeks selected are those that include the 15th of the month. The futures quotation used was the closing price on Wednesday.

Grain prices are Thursday prices for the weeks selected as reported in Grain Market News.[14] Hay prices are State estimates of monthly prices received by farmers as reported in Agricultural Prices (*36*).

For each feeding period, the futures contract selected for hedging was the one maturing the month after the cattle were sold. Since contracts mature only once every 2 months and a contract cannot be held beyond maturity, many cattle must be hedged in contracts maturing a month or more after the cattle are sold. This choice also avoids any sharp price movements that may tend to characterize delivery-month pricing in live cattle futures.

Profits from futures transactions were calculated under the assumption that hedging positions are terminated by buying back the futures rather than by delivery. Returns from futures trading equal the futures price change over the feeding period times the amount of the hedge. When futures trading costs were introduced, commissions and interest on margin deposits were included. The round term commission for trading live cattle futures is $36 per 40,000-pound contract. For this study, a margin of $500 per contract was assumed with interest at 7½ percent annually. On this basis, futures trading costs are 12¢ per hundredweight or $1.21 per head for 1,000-pound steers hedged over a 4-month period.

Price Bias in Cattle Futures

Haverkamp (*13*) noted a tendency for cattle futures to sell at a discount below the ultimate cash price and suggested that this reflects a risk premium demanded by speculators.[15] The task of measuring price bias or risk premiums in live cattle futures is particularly difficult because of the cycle in cattle prices and the shortness of the data series available.

Analysis of cattle futures price movements over the 6-year period, March 1965 to March 1971, shows that

Table 2.—Assumed buying and selling weights and feed consumption for Good and Choice short-fed steers and heifers

Item	Steers	Heifers
Initial weight .... pounds	692	667
Days on feed .... days	122	122
Daily gain [a] .... pounds	2.87	2.65
Total gain .... pounds	350	323
Finished weight .... pounds	1,042	990
Weight after shrink [b] .... pounds	1,000	950
Grain consumed per head: [a]		
Corn Belt and Colorado, corn .... bushels	37.9	35.6
High Plains, grain sorghum .... bushels	43.1	40.5
California:		
Grain sorghum .... bushels	21.5	20.2
Barley .... bushels	24.5	23.0
Hay consumed per head [a] .... tons	.26	.25

[a] Rates of gain are based on National Research Council data (*27*, p. 22). Feed consumption is based upon TDN requirements reported in the same publication.

[b] A 4 percent shrink is assumed.

holders of long positions have, indeed, gained on the average at the expense of holders of short positions. This gain is most pronounced during the last month of trading where the price increase has averaged 44¢ per hundredweight. Holding a short position in the near cattle futures contract over 18 successive 4-month feeding intervals from March 1965 to March 1971 would have resulted in an average loss of 59¢ per hundredweight, or about 15¢ per hundredweight per month. This amounts to $5.90 per head for hedging a 1,000-pound steer over a 4-month feeding period. However, the standard error of this estimate is $4.93 per head, so we are unable to reject the hypothesis that the bias is zero.

The estimated bias in the futures price can be adjusted for trend in the general level of cattle prices. The cash price of slaughter cattle increased approximately $6.50 per hundredweight over the 6-year period analyzed. This amounts to an average increase of 9¢ per month. The adjusted estimate of the bias is 15 - 9 = 6¢ per hundredweight per month, or about $2.30 per head, for 1,000-pound steers hedged over a 4-month feeding period.

To recapitulate, cattle futures price movements have favored the holders of long positions in the past, but this observed bias is not significantly different from zero from a statistical standpoint. Part of the observed bias can be attributed to the general rise in cattle prices that occurred over the period studied. The empirical evidence is simply insufficient to permit a firm conclusion about the existence or magnitude of the price bias in cattle futures. Consequently, in a subsequent section of this study, optimal hedging levels are reported for alternative assumptions about the bias.

Minimum-Risk Hedging Levels for 4 Types of Cattle at 5 Locations

Table 3 summarizes the estimates of minimum-risk hedging levels and hedging effectiveness for four types of cattle at five locations. These estimates were based on observations for 18 consecutive 4-month feeding periods starting in March 1965 and ending in March 1971. They were obtained using a least-squares regression algorithm where cash profits were entered as the dependent variable and futures profits plus dummy variables representing two of the three seasons were used as independent variables. The regression coefficient associated with the futures price variable is reported as the estimate of the minimum-risk hedge. As noted earlier, this estimate probably has a slight upward bias. The standard error of the coefficient as provided by the least-squares algorithm is also shown to provide an indication of the precision of the estimate. The square of the corresponding partial correlation coefficient is presented as an estimate of the effectiveness of the minimum-risk hedge, and the Durbin-Watson statistic is shown as an indication of the degree of serial interdependence in the sample.

The estimated optimal hedging levels range from -0.56 to -0.88. These may be interpreted as 0.56 to 0.88 unit of short futures per unit of slaughter cattle produced. The corresponding estimates of hedging effectiveness range from 36 to 57 percent. All the correlation coefficients between cash profits and futures profits are significantly different from zero at the 1 percent level, except one which is significantly different from zero at the 5 percent level.[16] We conclude that hedging at the minimum-risk level can reduce profit risk in all of the situations studied.

The table shows that location, grade, and sex have little impact on hedging effectiveness. The highest correlation was 0.73 for Choice steers in the Eastern Corn Belt and the lowest correlation was 0.60 for Good heifers in the Western Corn Belt. Sample correlations differing by this amount can be expected to arise more than half the time in samples of this size when the parent populations have identical correlations.[17] Hence, the evidence examined here does not reveal any statistically significant differences in hedging effectiveness among the cattle feeding situations studied.

Impact of Futures Trading Costs and Profit Expectations

The preceding results are applicable for the cattle feeder who expects his average profit from futures trading to be zero. This is a reasonable profit expectation if he is unable to forecast futures price changes and if he considers futures trading costs to be negligible. However, most hedgers will want to take futures trading costs into account and some may believe that futures price movements can be predicted. In this section, we explore how such variations in the hedger's profit expectations affect his optimal level of hedging.

When expected profits from futures trading are nonzero, we must resort to equation (5) to determine the optimal hedging level. In contrast to equation (6), we note that in equation (5) the expected returns for both the cash activity, μ_2, and the futures activity, μ_1, must be used to calculate the optimal hedging level. In other words, under these more general circumstances the optimal hedging level depends not only upon the variance and covariance of futures profits and cash profits, but also upon the levels of profit expected in both activities.

Table 3.—Estimated minimum-risk hedging levels and hedging effectiveness for four types of short-fed cattle at five locations [a]

Item	Eastern Corn Belt	Western Corn Belt	Colorado	High Plains	California
Choice steers:					
Min. risk hedge [b]	−0.88	−0.80	−0.84	−0.74	−0.76
Standard error	0.22	0.22	0.19	0.22	0.21
Effectiveness [c]	0.53	0.47	0.57	0.44	0.48
Durbin-Watson	2.30	2.63	1.85	1.85	2.50
Good steers:					
Min. risk hedge	−0.82	−0.64	−0.66	−0.71	−0.72
Standard error	0.19	0.19	0.18	0.21	0.22
Effectiveness	0.57	0.44	0.49	0.44	0.44
Durbin-Watson	1.96	2.74	2.57	2.13	2.43
Choice heifers:					
Min. risk hedge	−0.86	−0.75	−0.83	−0.70	[d] 0.76
Standard error	0.21	0.24	0.19	0.22	0.23
Effectiveness	0.54	0.42	0.57	0.42	0.45
Durbin-Watson	2.12	2.84	2.73	2.40	2.37
Good heifers:					
Min. risk hedge	−0.68	−0.56	−0.69	−0.63	([e])
Standard error	0.21	0.20	0.17	0.18	([e])
Effectiveness	0.43	0.36	0.53	0.45	([e])
Durbin-Watson	1.65	2.88	2.84	2.58	([e])

[a] Based upon observations for 18 consecutive 4-month feeding periods starting in March 1965 and ending in March 1971.

[b] The number of units of short futures per unit of slaughter cattle produced that minimizes price risk.

[c] The proportional reduction in the variance of profit obtained through hedging at the minimum-risk level.

[d] Prices for 700- to 900-pound heifers were used in the absence of a complete series of prices for 900- to 1,000-pound heifers.

[e] Prices not available.

Profits from cattle feeding are a residual after costs are subtracted from returns. Some of the costs are difficult to estimate and tend to vary from firm to firm depending upon the size of the feeding operation and the technology employed. Also, there is evidence that feeding is more profitable during certain seasons of the year than during other seasons, particularly in the Western Corn Belt, Colorado, and the High Plains. In these regions, the March-to-July feeding period has been most profitable, followed by the November-to-March feeding period and finally by the July-to-November feeding period.

Because expected profits from cattle feeding differ so much from firm to firm, no attempt is made here to prescribe optimal hedging levels for all of the situations studied. We shall instead illustrate how the optimal hedging level varies as expected profit varies for a particular situation. The situation selected is Choice steers in the Western Corn Belt fed from November to March.

For the 6-year period analyzed, the average return per head over costs of the feeder, grain, and roughage for Choice steers fed from November to March in the Western Corn Belt was just under $20. Other variable costs, including protein supplement, veterinary expense, labor, marketing expense, interest, and insurance on the cattle and feed probably amount to $10 to $15 per head for the typical feeder. Thus, the net profit tended to fall in the range of $5 to $10 on the average.

Table 4 shows calculated optimal hedging levels for Choice steers in the Western Corn Belt under two assumed levels of profit from cattle feeding and three assumed levels of futures trading costs. The three levels of futures trading costs are zero; $1.21 per head, representing only commissions and interest on margin deposits; and $3.51 per head, which includes these costs plus the adjusted estimate of the downward bias in futures prices reported previously.

Table 4.–Estimated optimal hedging levels and hedging effectiveness for short-fed Choice steers in the Western Corn Belt under alternative assumptions about expected profits and expected futures trading costs [a]

Expected cost of hedging per head	Expected cash profit per head	
	$5	$10
0	–0.80 (0.47)	–0.80 (0.47)
$1.21	–0.59 (0.44)	–0.70 (0.47)
$3.51	[b] 0 (0)	–0.45 (0.39)

[a] Figures in parentheses represent the proportional reduction in the variance of profits.

[b] In this situation, the gains from hedging are insufficient to cover hedging costs and the optimal solution calls for a zero position in futures.

The major conclusion from the table is that optimal hedging levels are quite sensitive to futures price bias, futures trading costs, and expected cash profits. Futures trading costs alone reduce optimal hedging ratios from -0.80 to -0.70 or -0.59 depending upon the cash profit level assumed. When the adjusted estimate of the downward bias in futures prices is added to trading costs, optimal hedging ratios drop to -0.45 in one case and to zero in the other case.

Because these results are based upon assumed levels of expected cash profits and expected futures profits, they are only illustrative. They show that the optimal level of hedging may be substantially smaller than the level of hedging that minimizes risk, and even a modest downward bias in futures prices markedly depresses the optimal hedging level.

Conclusions

This analysis of cash future price relationships in cattle feeding shows that the concepts of optimal hedging level, minimum risk hedging level, and hedging effectiveness can be defined in a manner consistent with portfolio theory and used to provide meaningful estimates of hedging potential. The major conclusions from the study are as follows:

1. Short hedging in cattle futures is a management tool that can help the individual or firm with fixed resources in cattle feeding to obtain preferred combinations of expected profits and risks. In contrast, the individual without fixed resources in cattle feeding has no reason to hedge. To him, speculation and custom feeding represent alternative ways of investing in the cattle feeding business.

2. For firms with the same nonlimiting fixed resources in cattle feeding, the optimal level of hedging is independent of differences in the degree of risk aversion. Thus, a single optimal hedging level which applies to a group of firms can be estimated.

3. The squared correlation between cash profits and futures profits provides a meaningful measure of hedging effectiveness when hedging costs are negligible and futures prices are unbiased. In this case, the optimal level of hedging is the level that minimizes risk. When hedging costs are positive and/or futures prices are biased against the hedger, a lower level of hedging is optimal and the proportion of the risk shifted through hedging is less.

4. Although cattle futures price movements have, on the average, favored holders of long positions in the past, the large variability in these price movements makes it impossible to determine if cattle futures prices are, in fact, biased.

5. The upper limit on the optimal hedging level ranges between 0.56 and 0.88 unit of short futures per unit of slaughter cattle produced for the situations studied. However, optimal hedging levels are depressed below these levels when futures trading costs and possible futures price bias are taken into account.

6. In the cattle feeding situations studied, about one-third to one-half of the price risk can be shifted through hedging at the optimal level.

7. Location, grade, and sex of cattle fed have little effect on optimal hedging levels and hedging effectiveness. This suggests that one slaughter cattle futures contract may be sufficient to serve cattle feeders' hedging needs throughout the United States.

This study leaves many questions about hedging potential in cattle feeding unanswered or only partly answered. Only a limited number of cattle feeding situations were examined. The precision of the empirical results is restricted because only 6 years of data on cattle futures prices were available for analysis. Seasonal differences in hedging potential and differences between continuous feeding and feeding one or two lots of cattle per year were not examined. The effects of changing interest rates and variations in the costs of feedlot services deserve to be more carefully explored. The study does not probe the dynamic aspects of hedging, particularly the potential gains from basing production and hedging decisions on changing price expectations or price forecasts. These matters appear to represent promising areas for further exploration.

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Footnotes

[1] Italic numbers in parentheses indicate items in the References.

[2] Theory suggests that the sharing of risks accomplished through efficient capital markets actually reduces the costs to society of bearing risks. Lintner (*24*) shows that the market price of risk declines as the size of perfect capital markets increases. He concludes: "Perfect capital markets are thus not merely an efficient *risk-sharing* mechanism: they are a remarkably efficient *risk-eliminating* mechanism. . ." (*24*, p. 98).

[3] Hicks (*19*) argued that forward trading contributes to efficiency by reducing inconsistencies in expectations and plans, but he noted that even with forward trading some sources of disequilibrium remain. In demonstrating how futures serve as a forward pricing mechanism in cattle feeding, Paul and Wesson (*28*) suggested that the spot-forward spread be viewed as the price of feedlot services. Ehrich (*6*) and others have attempted to determine how well cattle futures fulfill this forward pricing role, but experience to date does not permit a final conclusion.

[4] The prevalence of risk aversion can be supported theoretically by arguments based upon the decreasing marginal utility of wealth. The assumption of risk aversion does not imply that risk is minimized. It allows the possibility that the decisionmaker may be willing to accept large increases in risk for a small increase in expected returns. Furthermore, it does not rule out gambling when the stakes are sufficiently small. See Arrow (*1*, pp. 90-120) for a discussion of the theory of risk aversion.

[5] The term "basis" here refers to the difference between the futures price and a particular cash price at a point in time. Howell's work is reported in (*21*) and earlier publications cited therein.

[6] Price bias refers to the tendency for the futures price to lie below or above the cash price expected to prevail at the maturity of the future. A biased futures price will tend to move toward the expected cash price as contract maturity approaches.

[7] In each of these studies, the measure of profit variability employed was the variance or standard deviation of profit about its mean. A more general approach is to measure profit variability about its conditional expectation or forecasted value. This point is elaborated in my comment on the Tomek and Gray article (*17*). Furthermore, it is conceivable that a producer may be able to forecast profits more accurately with hedging than without hedging. He may thereby be able to obtain higher profits with hedging than without hedging by taking advantage of the more accurate forecasts and allocating resources to the activities with the highest predicted profits. An attempt to measure such gains is reported in my study of grain storage in Michigan (*16*). The development and testing of alternative profit forecasting schemes that might be used in hedging is beyond the scope of the current study.

[8] The assumptions and approach used here correspond to those employed by Markowitz (*25*) for the portfolio problem. However, inequality constraints imposed by resource limitations are not included since we are interested in situations where no constraints are binding. When the resource constraints are included, the model becomes somewhat more complicated, but the implications are unchanged for our purposes here.

[9] This result is a corollary to the "separation theorem" that Tobin (*31*, pp. 82-85) proved for portfolios. Johnson (*22*, p. 147) derived the result specifically for futures trading.

[10] The Taylor series expansion of $z = s_{12}/s_{11}$ evaluated at $s_{11} = \sigma_{11}$ and $s_{12} = \sigma_{12}$ proceeds as follows:

$$\begin{aligned} z = {} & \sigma_{12}/\sigma_{11} + (1/\sigma_{11})(s_{12} - \sigma_{12}) \\ & - (\sigma_{12}/\sigma_{11}^2)(s_{11} - \sigma_{11}) \\ & + 1/2\,[-(2/\sigma_{11}^2)(s_{12} - \sigma_{12})(s_{11} - \sigma_{11}) \\ & + (2\sigma_{12}/\sigma_{11}^3)(s_{11} - \sigma_{11})^2] + \ldots \end{aligned}$$

Taking expected values of both sides of the equality we obtain,

$$\begin{aligned} E(z) = {} & \sigma_{12}/\sigma_{11} - (1/\sigma_{11}^2)\,\mathrm{Cov}\,(s_{12}, s_{11}) \\ & + (\sigma_{12}/\sigma_{11}^3)\,\mathrm{Var}\,(s_{11}) + \ldots \end{aligned}$$

Goldberger (*7*, pp. 97-99) shows that the variance of the sample variance is as follows:

$$\begin{aligned} \mathrm{Var}\,(s_{11}) & = E\,(s_{11}^2 - Es_{11}^2)^2 \\ & = T^{-1}(\mu_4 - \sigma_{11}^2) - 2T^{-2}(\mu_4 - 2\sigma_{11}^2) \\ & \quad + T^{-3}(\mu_4 - 3\sigma_{11}^2) \end{aligned}$$

where T is the number of observations in the sample and μ_4 is the fourth moment about the mean. Under normality $\mu_4 = 3\sigma_{11}^2$ and,

$$\mathrm{Var}\,(s_{11}) = 2\,(T^{-1} - T^{-2})\,\sigma_{11}^2$$

Assuming further that the variance of s_{12} is not larger than the variance of s_{11} and that s_{11} and s_{12} have nonnegative covariance, we have $0 \leqslant \mathrm{Cov}\,(s_{12}, s_{11}) \leqslant \mathrm{Var}\,(s_{11})$. Approximate limits on $E(z)$ are then

$$(1 + U)\,\sigma_{12}/\sigma_{11} - U \leqslant E(z) \leqslant (1 + U)\,\sigma_{12}/\sigma_{11}$$

where $U = 2(T^{-1} - T^{-2})$. For $T = 16$,

$$1.117\,\sigma_{12}/\sigma_{11} - 0.117 \leqslant E(s_{12}/s_{11}) \leqslant 1.117\,\sigma_{12}/\sigma_{11}$$

[11] Alternative measures of hedging effectiveness can be defined which take expected profits or losses from the futures activity into account. But any such measure is arbitrary in that the magnitudes defined have meaning only if the individual's preferences between expected profit and risk are specified.

[12] Technical risk or output risk is disregarded in this study. In cattle feeding, output risk takes the form of variation in rates of gain and death loss. These tend to be relatively small in magnitude and virtually independent of price variation for the individual feeder. Procedures for dealing with output risks in analyzing hedging decisions have been developed by McKinnon (*26*). He deals with the case where basis risk is absent and points out that when output and price are uncorrelated the optimal hedge is not affected by the output risk.

[13] To the extent feasible, daily prices were used in the analysis to avoid averaging out part of the price variation. For the auction markets, however, daily prices are generated only for certain days of the week and these differ from market to market. Weekly averages of cash prices were used for feeder cattle and slaughter cattle so that the same series of futures prices could be used for the various locations. Slaughter cattle prices for Chicago and Omaha and feeder cattle prices for Omaha and Kansas City were obtained from Livestock, Meat and Wool Market News, Weekly Summary and Statistics (*37*). Other spot prices for cattle were obtained from the records of the Livestock Division, Agricultural Marketing Service, USDA.

[14] The corn prices at Denver were obtained from the Denver office of Grain Market News. Prices for other grains and other locations are those reported in weekly issues of Grain Market News (*35*).

[15] The notion that hedgers would be willing to pay speculators a risk premium combined with the excess of short hedging over long hedging implies that the futures price would tend to be biased downward, a phenomenon that Keynes (*23*) termed "normal backwardation." Efforts to measure normal backwardation, risk premiums, or price bias have produced mixed results. For example, Gray (*10*) found little evidence of risk premiums whereas Houthakker (*20*) concluded that the idea of normal backwardation or risk premiums has substantial empirical support. Rockwell (*29*) found "no significant tendency toward normal backwardation," but he concluded that in some markets speculators tend to gain at the hedgers' expense due to the superior forecasting ability of the speculators. Lintner's theoretical analysis of capital markets (*24*) suggests that the price of risk declines as the size of the market increases. Under equilibrium conditions we might therefore expect the market price of risk to become very small. This perhaps helps to explain why students of futures markets have had difficulty in finding empirical evidence of risk premiums.

[16] The tests are based upon a table in Snedecor (*30*, p. 174). Critical values for r at the 1 percent and 5 percent levels with 14 degrees of freedom are 0.623 and 0.497, respectively. The corresponding r^2 values are 0.388 and 0.247.

[17] This conclusion is based on the Z test as outlined in Snedecor (*30*, p. 178). The calculated Z's are 0.928 and 0.693. The standard error of their difference is $\sqrt{2/13}$ = 0.392. The calculated t is (0.928 − 0.693)/0.392 = 0.60. The probability of obtaining a t larger than this in samples of this size from two populations with the same correlation is approximately 0.56.

New Methods for Filbert Objective Yield Estimation

By William H. Wigton and William E. Kibler

Filbert estimating techniques can be improved by using refined procedures for selecting sample limbs and counting nut clusters. These procedures can reduce survey cost 25 percent and improve sampling and nonsampling errors. Counting nut clusters for two terminal limbs (4 percent of an average tree) by stripping them from limbs reduced counting errors considerably, compared with on-the-limb counts for primary limbs (15 percent of an average tree). The total cross-sectional area of primary limbs is inexpensive to obtain and can be used efficiently in a double sampling survey design.

Key words: Sampling; estimation; statistical methodology; fruit and nut counting.

Filbert production estimates for Washington and Oregon were made from 1955 to 1964 using both objective yield procedures[1] and data reported by growers (*3*).[2] The objective estimates were discontinued for economic reasons until 1968, when the demand for more complete and accurate information on quality and quantity of the crop increased. This paper discusses some work that has been done to increase the accuracy of objective yield estimates by improving (1) the definition of sampling units, (2) sample allocation, (3) estimating procedures, and (4) field counting procedures. The work described has applications for other fruit and nut crops where objective yield procedures have been or are being considered.

Sample Selection

Six filbert blocks (orchards) were used in the study. Rough sketches of the blocks were made with each tree represented by a square on graph paper. The sketches also indicated (1) the number of rows of trees in the block, (2) approximate number of trees in each row, (3) approximate number of trees for the entire block, and (4) location of the blocks in relation to barns, fields, houses, and roads bordering the blocks (figure 1).

A systematic sample of three or four rows and eight or nine trees in each row was selected in each block for the total study, using random starts. This assured a uniform distribution of sample trees throughout the block as shown in figure 1. The trunk and primary limb[3] measurements (cross-sectional areas or CSA's) of these trees were measured by using a special tape which is read directly in square inches.

Previous work (*1*) on other tree crops indicates that the sum of the primary CSA's for a given tree is more highly correlated with total yield than the one measurement of trunk CSA. Therefore, the sample trees were arrayed by the sums of the CSA's of their primary limbs. A subsample of three trees was systematically selected from this array as shown in table 1. Detailed counts and measurements were made for these three trees. The subsampled trees were flagged with engineering tape and photographed from two opposite sides during dormancy. A stereo camera was used so the three-dimensional effect could be used to identify limbs. The stereo slides were used to partition the trees into sampling units, first by identifying the primary limbs. Two randomly selected primaries per tree were further subdivided into terminal limbs.[4] All sample units (terminal limbs) were identified on photographs. Two terminals from each primary were chosen as sample units for making counts of nut clusters. Individual nuts cannot be identified until nuts are mature and hulls open so the individual nuts drop out. A cluster generally contains about four nuts but can have as few as one or as many as eight nuts.

[1] Estimation procedures based on actual plant or fruit characteristics measured or counted from randomly selected plots or limbs.

[2] Italic numbers in parentheses indicate items in the References, p. 46.

[3] Primary limbs or scaffolds are major limb divisions emerging from the main trunk (figure 2).

[4] Small limbs emerging from the primary limbs used as sample units for counting nuts (figure 2).

ORCHARD SKETCH SHOWING SAMPLE TREES WITHIN BLOCK: ABOUT 475 TREES IN BLOCK OF 18 ROWS, 28 TREES PER ROW

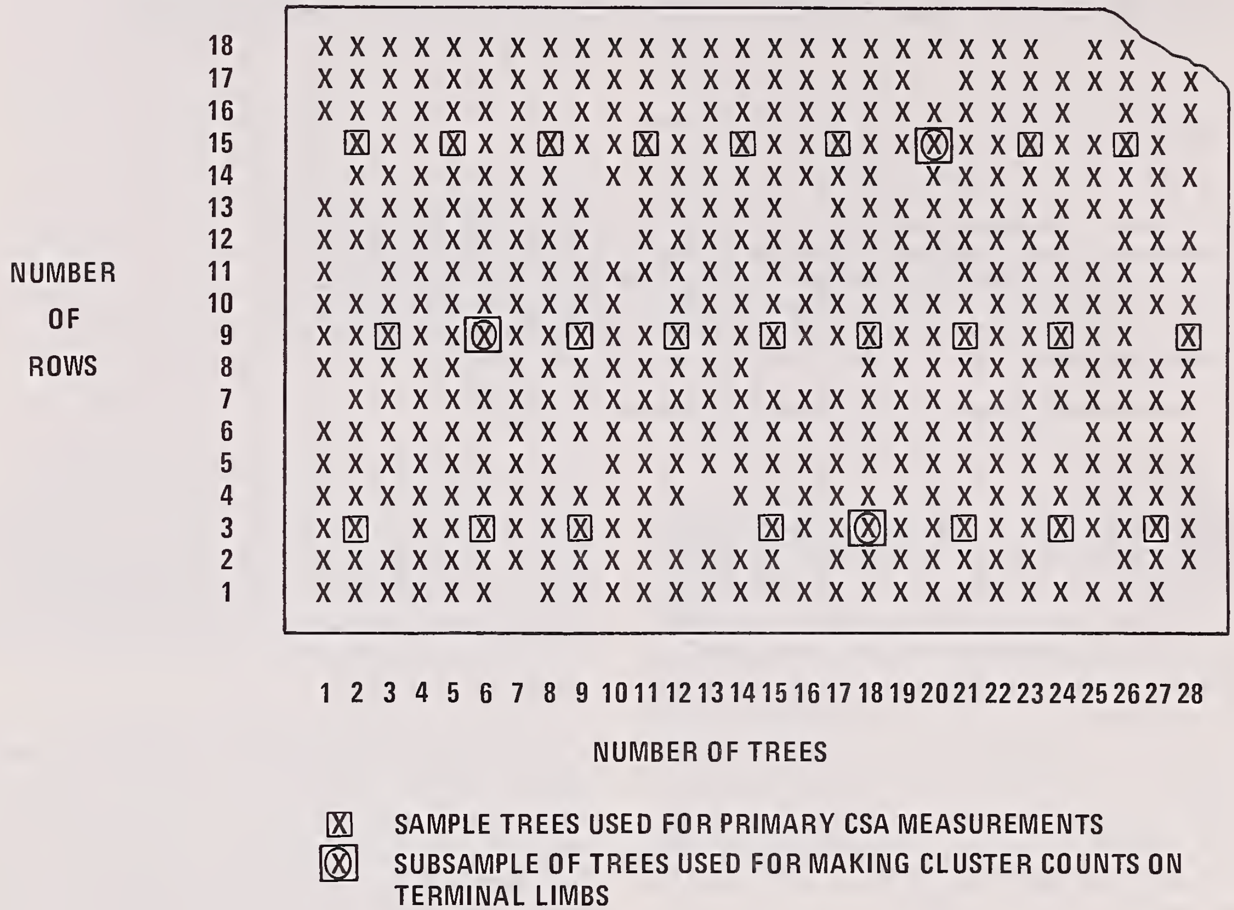

Figure 1

Table 1.—Sum of primary cross-sectional areas for sample trees shown in figure 1 arrayed with subsampled trees identified

Row and tree	Sum of primary CSA's	Row and tree	Sum of primary CSA's
	Square inches		*Square inches*
Row 9 Tree 12	93.4	Row 3 Tree 15	81.0
Row 15 Tree 5	89.7	Row 3 Tree 21	80.4
Row 3 Tree 24	88.2	Row 15 Tree 11	78.9
Row 15 Tree 20	[a]86.4	Row 3 Tree 9	78.7
Row 9 Tree 3	85.8	Row 9 Tree 24	77.6
Row 3 Tree 6	85.7	Row 15 Tree 26	77.6
Row 3 Tree 27	84.9	Row 15 Tree 8	76.2
Row 15 Tree 2	83.8	Row 3 Tree 2	76.0
Row 9 Tree 18	83.3	Row 3 Tree 18	[a]75.1
Row 9 Tree 15	82.6	Row 15 Tree 23	74.5
Row 15 Tree 14	82.2	Row 9 Tree 9	72.8
Row 15 Tree 17	81.6	Row 9 Tree 28	70.1
Row 9 Tree 6	[a]81.4	Row 9 Tree 21	67.8

[a]Subsample of trees for making cluster counts on terminals.

Field Procedures for Counting Clusters

In August, the selected trees were located again and all the primary limbs, identified on the photographs, were measured. Additional restrictions were placed on the size of the "primary limb" to help control variability. Its CSA could not be more than one-fourth of the sum of the CSA's of all primary limbs and it had to have at least two terminal limbs. One or more primary limbs on most trees were not within this range. If limbs were too large, they were divided into two or more primary limbs. Primary limbs without two acceptable terminal limbs were combined with another primary so the combination was within the defined range. This required a new selection of primary sample limbs and a partitioning of them into terminal limbs in the field. The CSA's of all terminal limbs on the selected primaries were

TRUNK AND LIMB STRUCTURE FOR A TYPICAL FRUIT OR NUT TREE

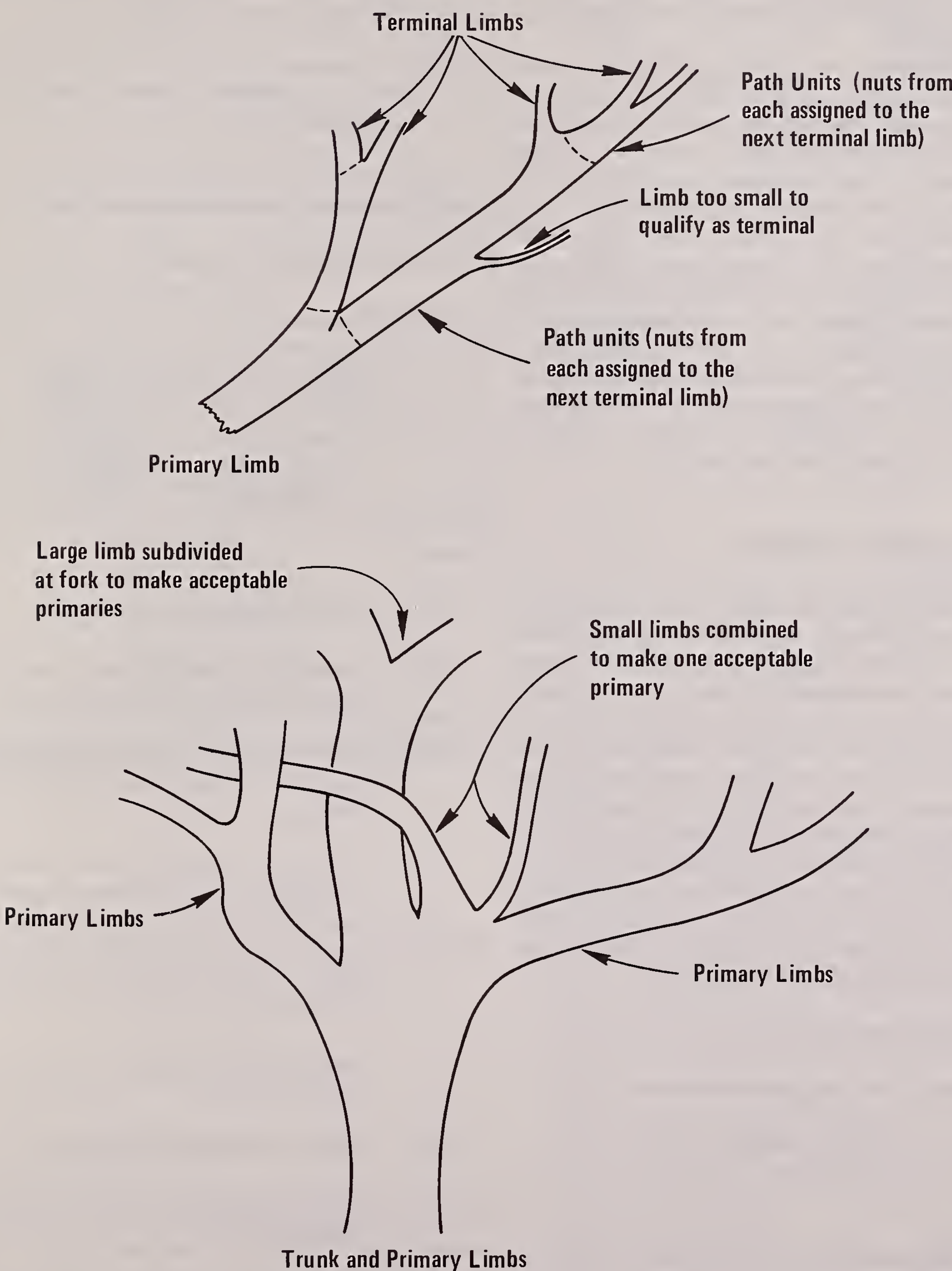

Figure 2

recorded. However, actual selections were made with equal probabilities. Any small limbs on a selected primary which had a CSA less than 0.8 square inch were treated as "path units" and the clusters were assigned to the closest terminal.

The nut clusters on the selected limbs were counted by two men. Sample limbs were assigned at random to the two counters. One counter used the method of partitioning the limb and counting by sections. A second man counted the nuts by starting at the base of the sample limb, counting outward, and recording one on a hand counter after each 15th cluster. After each completed his counts, they changed primary limbs and picked every cluster from one of the terminal limbs. This provided a quality check for the two counting procedures. The nut clusters were put in plastic bags, identified by block, tree, and limb, and sent to the State laboratory. Here the clusters were divided so individual nuts could be counted. The time required to complete each phase of the field work was recorded.

Estimating Models Evaluated

Two different types of models were considered in addition to the simple unbiased (direct expansion) estimate. In general, both the regression and ratio estimators use a double sampling approach. For a double sampling design to be effective, the related characteristic (auxiliary variable) must be highly correlated with the value being estimated and relatively inexpensive to obtain (compared with the variable under study). The double sampling designs were evaluated on two levels: (1) To estimate the number of nut clusters in a tree, and (2) to estimate the number of nut clusters on a primary. At each level, two possible covariates were studied–sum of primary CSA's and trunk CSA at the block level, and primary and terminal CSA's at the tree level.

Block Estimating Model–Regression

The model for the regression estimator is:

$$\hat{Y}_i' = \bar{Y}_i + b\,(\bar{X}_{il} - \bar{X}_{is})$$

where

$\bar{Y}_i'$ is the new estimate of nut clusters per tree for ith block

$\bar{Y}_i$ is the average number of nut clusters estimated per tree based on the three trees subsampled in the ith block

b is the slope of the regression line of Y_{ij}, the total number of nut clusters on the same tree, on X_{ij}, the sum of primary limb CSA's (or trunk CSA) on the jth tree in the ith block

$\bar{X}_{is}$ is the average CSA of all primary limbs (summed) for the subsample of trees for which nut cluster counts were made

$\bar{X}_{il}$ is the average CSA for all primary limbs (summed) for the large sample of trees.

The associated variance function is:

Within-block variance =

$$\underbrace{\frac{S_t^2(r^2)}{n'} + \frac{S_t^2(1-r^2)}{n}}_{\text{between-tree variance}} + \underbrace{\frac{S_p^2}{nm} + \frac{S^2_{ter}}{nmt}}_{\text{within-tree variance}}$$

where

S_t^2 = variance component between trees

S_p^2 = variance component between numbers of nut clusters on primary limbs within trees

S^2_{ter} = variance component between numbers of nut clusters on terminal units within primary limbs

r^2 = coefficient of determination between total nut clusters and the covariate measure; i.e., trunk CSA or sum of primary limb CSA's

n' = number of trees for which CSA measurements were obtained

n = number of trees in the subsample selected for objective counts

m = number of primaries selected per tree

t = number of terminal sample units selected per primary limb.

The amount of actual gain in terms of reduced variance for this model depends on (1) the degree of correlation between total nut clusters on a tree and tree size, (2) the magnitude of the between-tree nut count variance compared with the magnitude of the within-tree

nut count variance, and (3) the number of observations for the large and small samples. The estimate of the regression slope b is better if the selected trees vary considerably in size (such as sum of primary CSA's). This is because the variance of b is $S_e^2/\Sigma x^2$ where S_e^2 is the mean square deviation from regression. The larger the Σx^2, the smaller the variance of b. Thus, trees for the detail study were selected systematically from a list of trees arrayed by sizes (sum of primary CSA's).

The first step in testing the suitability of a regression model is to determine whether tree data from different blocks can be pooled. A sequential test procedure, starting with the most complex model and proceeding to the least complex model, was used.

This procedure is an analysis of variance (AOV) which tests a sequence of hypotheses about the suitability of combining data from different blocks in computing the regression coefficients. The following sequence of hypotheses is terminated with the first significant F value.

(1) Can an average within-block slope be used for all pooled data, or is a different slope and intercept necessary for each block (figure 3)?

$$H_o\colon\ \hat{Y}_{ij} = a_i + bX_{ij}$$

$$H_a\colon\ \hat{Y}_{ij} = a_i + b_iX_{ij}$$

(2) Can one intercept (or mean) and slope be used or should a common slope, but separate intercept, be used for each block (figure 4)?

$$H_o\colon\ \hat{Y}_{ij} = a + bX_{ij}$$

$$H_a\colon\ \hat{Y}_{ij} = a_i + bX_{ij}$$

(3) Is a regression equation useful or would the mean, $\bar{Y}$, be appropriate; i.e., is $b = 0$ (figure 5)?

$$H_o\colon\ \hat{Y}_{ij} = \bar{Y}_i$$

$$H_a\colon\ \hat{Y}_{ij} = a + bX_{ij}$$

The basic estimating model is established by answering these questions.

The top part of table 2 is a standard AOV table for the estimated number of cluster counts. This top section shows the partitioned sums of squares used to compute the correlation coefficient. In testing the sequence of hypotheses, one starts at the bottom of table 1 and works up. The first F-value (1.52) is not significant; thus, H_o: $\hat{Y}_{ij} = a_i + bX_{ij}$ is not rejected and the next test is considered. The second F-value is significant; therefore, H_a: $\hat{Y}_{ij} = a_i + bX_{ij}$ is the model indicated by the data.

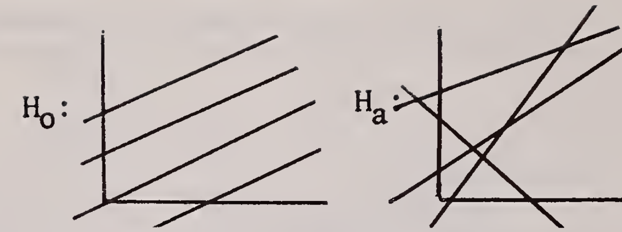

Figure 3

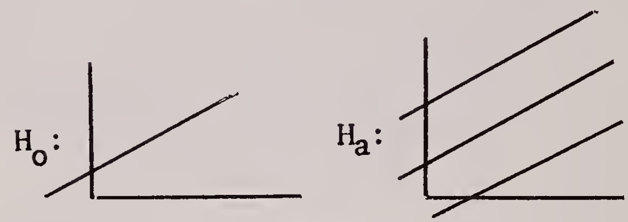

Figure 4

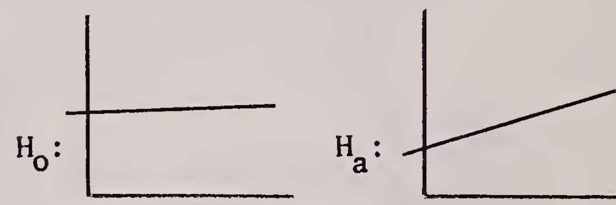

Figure 5

An average within-block slope may be used for the trunk CSA's for all blocks. This slope predicts ($\hat{Y}_{ij}$) for a unit change in the trunk CSA (X_{ij}). The regression model ($\hat{Y}_{ij} = a_i + bX_{ij}$) is changed to the double sampling model ($\hat{Y}_i' = \bar{Y}_i + b\,(\bar{X}_{il} - \bar{X}_{is})$ (2) by observing that $a_i = \bar{Y}_i - b\bar{X}_{is}$, where $\bar{X}_{il}$ is the large sample value for the covariate and $\bar{X}_{is}$ is the value for the small sample.

Similar results were obtained using the sum of the primary CSA's rather than the trunk CSA as the independent variable. Again, the first F-value (0.52) is not significant. The null hypothesis ($\hat{Y}_i = a_i + bX_{ij}$) is accepted and the next test is considered. The next F value (15.48) is highly significant and the testing stops. The model for grouping these data is $\hat{Y}_{ij} = a_i + bX_{ij}$, the same as for the trunk CSA.

After establishing the model for combining the data, correlation coefficients were computed. The within-block correlations were computed by adding the sums of squares adjusted for the block means, and using these values to figure the correlation in the usual manner; i.e.:

Table 2.—Analysis of variance testing various hypotheses about the suitability of regression lines [a]

Source of variation	Degrees of freedom	Sums of squares	Mean square	F-test	Hypothesis
Between blocks	5	17,829,392	3,565,878	[b]8.62	H_o: $\bar{Y}_i - \bar{Y}_k = 0$
Within blocks	12	4,962,781	413,565	-----	H_a: $\bar{Y}_i - \bar{Y}_k \neq 0$
Total corrected sums of squares	17	22,792,174	-----	-----	
Regression (a, b)	1	1,566,472	1,566,472	-----	H_o: $\hat{Y}_{ij} = \bar{Y}$
Error 1	16	21,225,701	1,326,606	-----	H_a: $\hat{Y}_{ij} = a + bX_{ij}$
Regression ($a_1 \ldots a_6$, b)	5	16,948,263	3,389,653	[b]8.72	H_o: $\hat{Y}_{ij} = a + bX_{ij}$
Error 2	11	4,277,438	388,858	-----	H_a: $\hat{Y}_{ij} = a_i + bX_{ij}$
Regression ($a_1 \ldots a_6$, $b_1 \ldots b_6$)	5	2,391,979	478,396	1.52	H_o: $\hat{Y}_{ij} = a_i + bX_{ij}$
Error 3	6	1,885,459	314,243	-----	H_a: $\hat{Y}_{ij} = a_i + b_i X_{ij}$

[a]X = trunk cross-sectional area, Y = estimated total of nut clusters.
[b]Indicates significance at 1 percent level.

Table 3.—Analysis of variance on the regression equations [a]

Source of variation	Degrees of freedom	Sums of squares	Mean Square	F-test	Hypothesis
Between groups	5	383,028	76,605	7.01	H_o: $\bar{Y}_i - \bar{Y}_k = 0$
Within groups	30	327,732	10,924	-----	H_a: $\bar{Y}_i - \bar{Y}_k \neq 0$
Total corrected sums of squares	35	710,760	20,307	-----	
Regression (a, b)	1	63,747	63,747	-----	H_o: $\hat{Y} = \bar{Y}$
Error 1	34	647,013	19,030	-----	H_a: $\hat{Y} = a + bX$
Regression ($a_1 \ldots a_6$, b)	5	431,619	86,324	[b]11.62	H_a: $\hat{Y}_i = a + bX$
Error 2	29	215,394	7,427	-----	H_a: $\hat{Y}_i = a_i + bX$
Regression ($a_1 \ldots a_6$, $b_1 \ldots b_6$)	5	30,794	6,159	.80	H_o: $\hat{Y}_i = a_i + bX$
Error 3	24	184,000	7,692	-----	H_a: $\hat{Y}_i = a_i + b_i X$

[a]X = cross-sectional area of the primary scaffold, Y = estimated total nut clusters on the primary scaffold within trees.
[b]Indicates significance at 1 percent level.

$$r = \sqrt{\frac{(\Sigma\Sigma xy)^2}{(\Sigma\Sigma x^2)(\Sigma\Sigma y^2)}}$$

The correlation coefficient for the sum of CSA's for primary limbs with estimated total nut clusters was highly significant (r = 0.95). However, the correlation for trunk CSA with total nut clusters was not significantly different from zero at the 0.05 level.

Further study was done on the cost of obtaining these measurements in terms of time required for (1) walking from one tree to another, and (2) making the various measurements at the tree. Time required to go from one tree to another would be the same for either variable (trunk CSA or sum of primary CSA's). The time required at the tree for obtaining (1) the sum of the primary CSA's was about 3 minutes, and (2) the trunk CSA was about 1 minute. Thus, the time required for both measurements was 4 minutes per tree for one person. These measurements need not be redone each year and could be used for about 4 years.

Tree Estimating Models—Regression and Ratio

To determine whether a ratio rather than a regression estimator should be used, one must satisfy the double requirements that (1) the correlations must be significant; i.e., r generally greater than $1/2\,(S_x/\bar{X})/(S_y/\bar{Y})$ and (2) the ratio of $\frac{b^2}{a^2}\,\frac{(1-f)}{n}$ must be greater than $\frac{\bar{X}^2\,V(1/\bar{X})}{S_x^2}$ (4) (a and b are the parameters of the regression equation and $V(1/\bar{X})$ is the variance of the harmonic mean).

If the correlation is large enough, then the second criterion must be met. It is less binding since the

Y-intercept a can frequently be reduced by a simple transformation. For example, if the correlation is high and the slope b is large, but the intercept is also large (figure 6), a simple transformation of the X-variable can reduce the Y-intercept to zero (figure 7).

The regression estimator is not restricted by the value of a single Y intercept if a within-block model is used. A single translation of the regression as shown in figures 6 and 7 would be impossible if a new intercept were required for each block.

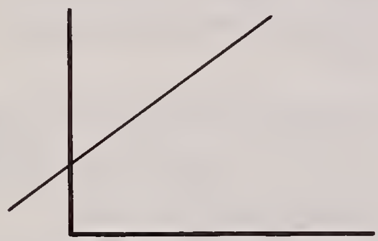

Figure 6

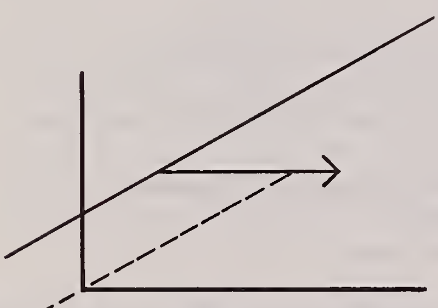

Figure 7

Tree Estimating Model Using Primary Limbs

The size of the primary limbs could range from about 2.0 up to about 20.0 square inches, insuring a wide range of sizes in the sample.

To evaluate which estimation procedure is more efficient for primary limbs, r was compared with $1/2\ (S_x/\bar{X})/(S_y/\bar{Y})$. To compute the correlation coefficient, it was necessary to determine how the data should be combined. Table 3 shows the tests for combining within-tree data. The model testing procedures for this analysis were the same as those described previously for trees.

The model for utilizing primary limb data from the different blocks was found to be $\hat{Y}_{ij} = a_i + bX_{ij}$, where b is the average within-block slope for all data and a different intercept a_i for each ith block must be computed. $\hat{Y}_{ij}$ is total clusters on jth primary limb in ith block and X_{ij} is size of the jth primary in the ith block.

The correlation coefficient (assuming one average slope) can be computed from the values in table 4 by dividing the regression sum of squares by the within-group sum of squares and taking the square root of the quotient. The correlation coefficient is slightly larger than $1/2\ (S_x\ /\ \bar{X})\ /\ (S_y\ /\ \bar{Y})$. This relationship is based on an approximation of the mean square error of the classical ratio estimate. The inequality is approximate and if the correlation is high and the slope large (as for this case) the size information may still be helpful. The correlation computed was between X_{ij} (the size of the jth primary in the ith block) and the $\hat{Y}_{ij}$ (estimated number of clusters on the same limb).

The second inequality necessary for the ratio estimator to be efficient involves the slope and the intercepts:

$$\frac{b^2}{a^2}\frac{(1-f)}{n} > \frac{\bar{X}^2 V\,(1/\bar{X})}{S_x{}^2}$$

or,

$$\frac{b^2 S_x{}^2\,(1-f)}{n\bar{X}^2\ \ V\,(1/\bar{X})} > a^2$$

Inserting the computed values for the variables, we conclude that a must be less than 64. The intercepts computed for the six blocks were: $a_1 = 42$, $a_2 = 125$, $a_3 = -7$, $a_4 = 111$, $a_5 = 327$, $a_6 = 12$. In three blocks (a_2, a_4, and a_5) the ratio estimator would have been more efficient and in the other three (a_1, a_3 and a_6), the ratio estimator would be less efficient than the simple direct expansion. Furthermore, the intercept could not be changed by a single linear transformation because the intercepts varied so widely (−7 to 327). For this reason, a within-block regression estimator is better using the following model:

$$\hat{Y}_i = \bar{Y}_i + b\,(\bar{X}_{il} - \bar{X}_{is}) = \bar{Y}_i + b\bar{X}_{il} - b\bar{X}_{is}$$

where $\bar{Y}_i - b\bar{X}_{is}$ is the block intercept a_i, $\hat{Y}_i$ is the double sampling estimate of the number of total clusters per tree in the ith block, $\bar{Y}_i$ is the average of the direct expansion estimates for trees in the ith block, b is the overall regression coefficient, $\bar{X}_{il}$ is the average primary size for the block, and $\bar{X}_{is}$ is the average size of the primaries sampled.

Since the coefficient of determination is 0.34 and the slope is significant, use of the primary limb size data should reduce the primary variance component by about

Table 4.—Within-block sums of squares used to compute correlation coefficient

Source of variation	Sum of squares
Within groups of Y	327,732
Error 2	215,394
Regression (assuming one b)	112,338

$r^2 = \frac{112{,}338}{327{,}732} = 0.343 \quad r = \sqrt{0.343} = 0.586 \quad (S_x / \bar{X}) = 0.608$

$(S_y / \bar{Y}) = 0.521$ and $1/2\,(S_x / \bar{X}) / (S_y / \bar{Y}) = 0.583$

one-third. Data on more blocks would help evaluate the reduction achieved by using CSA's of primary limbs in the estimation process.

Terminal Limbs Within Primary Limbs

The primary sample units (SU's) were subdivided into terminal SU's. This unit was defined as any limb with a CSA between 0.8 and 2.5 square inches. The average terminal SU had 50 nut clusters and took approximately 13 minutes to count. Two estimation schemes were studied: Equal probability selection with expansion by reciprocal of probability, and expansion using terminal size as an auxiliary variable in a ratio or regression estimate.

To determine which method of estimation was more efficient the same test discussed earlier was used. The F-value (15.46) for the second test was significant. The model using one average slope with a different intercept is also the best model for combining data for the terminal limb sample stage. For this analysis, $r = 0.20$, which is less than $1/2\ (S_x/x)\ /(S_y/y) = 0.34$. Thus, the first criterion necessary for size to be used in the estimation procedure using a ratio estimator is not met. Neither the ratio nor the regression estimation scheme, which uses the terminal size, would reduce the variance because of the very low correlation. Therefore, if the terminal SU's are restricted in size from 0.8 to 2.5 square inches, then the simple unbiased estimator is more efficient than estimators using limb sizes in the estimation process.

Optimum Number of Trees, Primary Limbs, and Terminal Limbs

Two sample allocations were optimized: (1) optimum values for trees n, primaries within trees m, and terminals within primaries t, and (2) the optimum ratio of trees measured to trees counted.

Both optimizations assumed that all selections would be with equal probability with variance components estimated from sample data. The estimating model for the average tree within the kth block is:

$$Y_{k.} = \frac{1}{n} \sum_{i=1}^{n} \frac{h_{ki}}{m} \sum_{j=1}^{M} \frac{M_{kij}}{t} \sum_{w=1}^{t} X_{kijw}$$

where

X_{kijw} = number of filbert clusters for the wth limb of the jth primary on the ith tree in the kth block

t = number of terminal sample units selected

M_{kij} = number of terminals on the jth primary in the ith tree in the kth block

m = number of primary sample units selected

h_{ki} = number of primary sample units on the ith tree in the kth block

n = number of sample trees per block.

Its associated variance formula is:

Total variance =

$$\frac{S^2{}_B}{k} + \frac{S^2{}_T}{kn} + \left(\frac{\bar{M}-m}{\bar{M}}\right)\left(\frac{S^2{}_p}{kmn}\right) + \left(\frac{\bar{T}-t}{\bar{T}}\right)\left(\frac{S^2{}_{Ter}}{knmt}\right)$$

and the appropriate cost function is:

Total cost =

$$(k)\,C_B + (kn)\,C_T + (knm)\,C_p + (knmt)\,C_{Ter}$$

where

k = number of blocks in sample

$S^2{}_B$ = variance component between blocks

C_B = cost of going from block to block (or block to home)

$S^2{}_T$ = variance component between trees

C_T = cost of going from tree to tree within a block and breaking the tree into primary units

S^2_p = variance component between primaries

C_p = cost of selecting one primary and breaking it into terminal sample units

S^2_{Ter} = variance component between terminals within primaries

C_{Ter} = cost of selecting and counting one terminal

$\overline{M}$ = average number of primaries on a tree = 5.89

$\overline{T}$ = average number of terminals on a primary = 5.

According to Snedecor and Cochran (5), the optimum values for t, m, and n are:

$$t = \sqrt{\frac{C_p S^2_{Ter}}{C_{Ter} S^2_p}}; \quad m = \sqrt{\frac{C_T S^2_P}{C_p S^2_T}}; \quad n = \sqrt{\frac{C_B S^2_T}{C_T S^2_B}};$$

The numerical values which were substituted are found in table 5. The optimum values rounded to integers are n = 3, m = 1, and t = 2. The next step is to find the optimum ratio of trees measured to trees counted. To optimize the ratio n'/n, again variance and cost functions are necessary. For this, a within-block function is needed and is as follows:

$$\text{Within-block variance} = \frac{S^2_T}{n} + \frac{S^2_P}{nm} + \frac{S^2_{Ter}}{nmt}$$

This must be changed to include double sampling at the tree level as follows:

Within-block sampling variance =

$$\frac{S^2_T(r^2)}{n'} + \frac{S^2_T(1-r^2)}{n} + \frac{S^2_P}{nm} + \frac{S^2_{Ter}}{nmt}$$

Table 5.—Summary of costs and variance components for the four stages of sampling

Source	Cost in minutes	Variance component
Blocks	150	118,113 = S^2_B
Trees	18	115,519 = S^2_T
Primaries	9	[a] 91,334 = S^2_P
Terminal sample units	16	[a] 554,293 = S^2_{Ter}

[a] Adjusted for average finite population correction factors.

Within-block double sampling cost =

$$n' C_T' + n C_T + nm C_p + nmt C_{Ter}$$

where C_T' is cost of measuring a tree, 4 minutes per tree, but could be used for 4 years so that an average of 1 minute per year was used, n' is the number of trees selected at random to measure, and r^2 is the coefficient of determination between the estimated quantity (total nut clusters) and the auxiliary variable (measure of tree size). In this study, we have recommended the sum of primaries as the covariate and assumed r^2 = 0.7; somewhat below the 0.95 observed in the section on the block estimating model.

The optimum ratio is found by forming the product of the variance and cost functions, differentiating with respect to n' and n, solving for each and forming the ratio.

The ratio before substitution is:

$$\frac{n'}{n} = \sqrt{\frac{S^2_T(r^2)(C_T + m\,Cp + mt\,C_{Ter})}{C_{T'}\left(S^2_T(1-r^2) + \frac{S^2_P}{m} + \frac{S^2_{Ter}}{mt}\right)}}$$

Using the variance components from table 5, and the cost values from above, n, m, and t as given indicate a ratio for n'/n of 3.2. Since three trees per block should be selected for counts, 10.2 is the optimum real number of trees which should be measured for the double sample. Operationally, 12 trees should be selected for measurements because 12 is a multiple of three and a rotation system for selecting the subsample for detailed counts and measurements could be worked out.

Selecting Trees, Primary Limbs, and Terminal Limbs

A sample of 12 trees should be selected at random for each block for obtaining the sum of primary limb CSA measurements for all primaries on each tree. These sums should be arrayed and a subsample of three trees systematically selected for identifying terminal limbs and making detailed cluster counts. The regression estimation technique should be used to adjust the estimated number of clusters for the subsample of trees for differences in tree size compared to the large sample of 12 trees.

For each of the three subsample trees one primary limb should be selected using equal probabilities (see figure 2). The selected primary limbs should be subdivided into terminal limbs and two of these selected for

making counts of nut clusters. Counts should be made by stripping all clusters from the sample terminals (see following section). This eliminates the need for a quality check on counts made. The number of clusters for the sample trees can then be estimated using a regression model where the direct expansion estimate for clusters (i.e., number of terminal limbs times nut clusters counted times number of primary limbs for tree) is adjusted for differences in the size of the sample primary and the average size for all primaries on the tree.

Errors in Counting

Information from quality checks from current survey procedures shows that the number of clusters on sample limbs has been undercounted. Data on counting accuracy were obtained for each person counting by having the supervisor strip all clusters from a subsample of terminal limbs which had first been counted with the usual on-tree counting procedure.

When the number of nut clusters missed (strip counts minus on tree cluster counts) is plotted against strip counts, the graphs indicate that a proportional relationship exists. The fitted line has a positive slope and goes approximately through the origin. This indicates that a factor could be applied to a limb count to adjust for undercounting. However, since the optimum terminal SU size is very small (CSA between 0.8 and 2.5 square inches), or generally between 1.7 and 2.0 percent of the tree, clusters for the entire limb can be stripped and counted. This eliminates some quality check work as most undercounts are usually associated with overlooking clusters partially hidden by leaves. Stripping eliminates most of this problem since counts are not made until the entire limb has been stripped and rechecked to see that no clusters were overlooked. Checks made to evaluate the accuracy of stripping found about 3 percent of the clusters not stripped. This compares with an undercounting of about 8 percent for prior methods.

Operational Survey

The first operational survey using the sampling techniques developed was completed in 1971. This survey required a sample of about 150 blocks, compared with 350 required when using the previous technique of selecting a primary and counting all the nut clusters on it (about one-seventh of a tree). The derived sampling error from the new sample procedure was about 5 percent, 1 percent below the previous level, even though the number of blocks visited was reduced by 200. The new sampling procedure reduced survey costs by about 25 percent.

Summary and Conclusions

The sum of primary CSA's (1) is highly correlated with the estimated number of nut clusters per tree, (2) is inexpensive to obtain, and (3) can be used efficiently in a double sampling survey design. Primary limbs should be selected with equal probability and their size (CSA) used in the estimation process. Terminal limbs with CSA's between 0.8 and 2.5 square inches, selected with equal probabilities, should be used as sample units. The optimum sample allocation within a block is three trees, one primary limb per tree, and two terminal limbs per primary.

All nut clusters on selected terminals should be counted (stripped), picked and bagged. An independent quality count survey should be made a few days after the regular survey period to determine whether the proper limb was stripped and any nut clusters were missed. Bare tree photography for sample trees should be used for selecting primary and terminal limbs, and for the quality check survey.

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BOOK REVIEWS

Institutions in Agricultural Development

Edited by Melvin G. Blase. Iowa State University Press, Ames, Iowa, 50010. 247 pages. 1971. $5.95.

This book is an outgrowth of a project initiated in 1967 by the International Rural Institutions Subcommittee of the North Central Land Economics Research Committee (NCR-6).

The objective of the book is to provide "a comprehensive view" of the institutions that are most important to the agriculture of the developing countries. Eleven different types of institutions are discussed by 32 authors and discussants. The book, in my judgment, falls short of its objective, even though it contains much that will interest those concerned with technical assistance.

For the most part, the authors and discussants focus on what the respective institutions do. Only slight attention is given to administration and management—how they do what they do and how they are organized to do it. The article by Nicolaas Luykx on "Rural Governing Institutions" is one of the few exceptions. It focuses on both the processes which flow through institutions and the structures of institutions.

Neither the editor nor the distinguished contributors attempted to grapple with the key problem of setting priorities among institutions and changes within institutions. This is a serious omission. Priority determination is central to development efforts. At the least, it should have been possible for the authors to have outlined a framework for comparison and analysis with which to determine priorities. Its omission suggests that our knowledge of institution building is still extremely limited.

While 11 types of institutions are included, others such as tax systems, ministries of agriculture, State and national legislatures, and judicial units dealing with agriculture are omitted. Why? Let me suggest one possibility. Of the 32 contributors, over two-thirds are professors in U.S. universities. For a long time, institution building has largely meant "what U.S. universities do overseas." It seems to be virtually forgotten that institution building occurs outside of university contracts, too, or at least it should.

Erven Long asks if U.S. foreign assistance policy should be concerned with the functioning of factor markets in developing countries. He does not offer an answer. Even so, his discussion includes important insights for those concerned with factor markets.

C. J. Martin discusses the appropriate organizational location of the planning function. "Where the economic policy control is exercised" is the answer. G. Edward Schuh constructively identifies five factors which reduce effectiveness of planning institutions.

The relevance of land grant institutions to the developing countries is debated. Ruttan opts for the foundation-type research institutes. Blase counters by suggesting that a comparison of foundation programs in countries not mentioned by Ruttan to selected university contract programs focusing on institution building would give a conclusion opposite to that reached by Ruttan. In all of this discussion, I was impressed that no reference was made to the fact that while the International Rice Research Institute (IRRI) and the International Maize and Wheat Improvement Center (CIMMYT) have been "international" in scope, their management and administration were American, virtually unfettered by the management and administrative approaches of the developing countries. This arrangement, of course, contrasts sharply with that encountered in technical cooperation among U.S. and foreign universities and U.S. and foreign government offices.

Management and administration can, of course, have an overwhelming influence on institutions in agricultural development. It is surprising that they did not receive more attention in this book. They must receive high priority in institution building in the future and books on the subject by university professors or Government bureaucrats should focus on them.

Lyle P. Schertz

Agricultural Development: An International Perspective

By Yujiro Hayami and Vernon W. Ruttan. The Johns Hopkins Press, Baltimore, Md. 21218. 307 pages. 1971. $10.

Part I of this book might have been subtitled "an encyclopedia of agricultural development theory." The authors demonstrate by their outline and analysis of

development theories that the dearth of publications of a decade ago has been filled to overflowing.

The authors build selectively on the theories of others in formulating their theory of induced innovation. Price is central to their thesis as the mechanism by which changes in supply and demand signal the opportunities for economic gain. Dialectic interaction between producers and innovators results in the development of new technologies to overcome the constraints on production. Artificial manipulation of prices by Government policies distorts the signals and frequently leads to a misapplication of resources, and the failure of developmental efforts.

Innovation by research scientists and administrators in the public sector is motivated by hope of reward in terms of professional recognition, which is influenced to a marked degree by the economic returns accruing from the adoption of the innovation.

In agriculture, technological and institutional innovations must be adapted to changes in resource endowments and in product demand of a particular place at a particular time in economic history. Therefore, research and development programs must be decentralized to the microlevel but must have satisfactory linkages to the larger country, regional, and world scientific and technological communities. The research and education capabilities of a society are critical factors in its development.

The authors identify two principal constraints on production: Scarcity of land and scarcity of labor. The former are operative in the less-developed countries of southeast Asia while the latter are operative in most of Africa and Latin America. Limitations of land may be overcome by increasing biological and chemical inputs while constrictions due to labor shortages may be overcome by mechanical inputs. At higher levels of production, these factors become complementary and supplementary, particularly after industrialization of the country.

However, unless the human resources at all levels—the farmer, the scientist, the businessman, and the public administrator—are sufficiently well developed, the opportunities for increases in productivity will not be recognized or wrong choices may be made. Such failures partially account for the agricultural productivity gap among countries.

The authors validate their theories both through econometric techniques and through the examination of historical developments in various countries. Developments in Japan and the United States are chosen for detailed examination, as they represent the two extremes of land resource constrictions and labor scarcity. However, some of the briefer analyses, such as the transfer of rice technology from Japan to Taiwan and Korea during the 1920's and 1930's, provide strong support for their theories. The example of Denmark's adjustment from a grain exporting economy to a meat and dairy exporting economy at the end of the 19th century provides some useful insights for dealing with second and third generation problems of the "green revolution." However, the authors stress that the direct transfer possibilities of the experiences of others are negligible because conditions are never perfectly replicated.

Hayami and Ruttan have made an important contribution to development theory. Their microeconomic approach to the analysis of development processes presents a strong challenge to macroeconomic theories such as W. W. Rostow's "stages." The macroplanning which has dominated much of development planning in recent years is diametrically opposed to the reliance on a free market advocated by the authors.

Jane M. Porter

Developing the Third World: The Experience of the Nineteen Sixties

Edited by Ronald Robinson. Cambridge University Press, 32 East 57th Street, New York, N.Y. 10022. 289 pages. 1971. $13.50.

The papers in this valuable collection are concerned with what might be termed the practical politics of developing the third world. The task addressed was to correlate economic priorities with political and human needs, all of which are in competition with scarce resources. It is abundantly clear that each author has experienced some of the hard realities and frustrations of struggling to promote a country's economic growth. The articles are notable for their insight and clarity of presentation. The discussions of the many cases of failure in the programs and the limited cases of success present an imposing critique of development policies of the past decade; more important, however, the articles offer implications for the 1970's.

A major concern of the developing nations' leaders has been the proper developmental role of industrialization as compared with agriculture. Papers from the early 1960's usually gave a great deal of weight to high capital-output ratios as the overriding need to most efficiently maximize output, employment, and the social welfare. Not surprisingly, therefore, public investment funds were repeatedly preempted by industrial projects. The agricultural sector, which in developing countries

often provides a livelihood for over half of the population, received lip service but little else.

However, there were several catches to this "industry first" theory. If investment was used for import substitution of consumer goods, it would not earn foreign exchange but only provide one means of saving some. On the other hand, it would require heavy initial and continuing capital goods imports. The ability of the nation to compete in world markets would depend heavily on preferential treatment from the developed nations. And, finally, inefficient, small-scale industrial operations could only burden the national economy.

It was expected that the internal savings necessary to finance capital investments would come largely from agricultural surpluses. Unfortunately, this anticipated surplus was doomed by rates of population increase that outstripped gains in output and productivity. Even with birth control, it is doubtful that this source of savings would have been able to pay the heavy capital costs of modern technologies.

By the middle of the decade, such realizations had led briefly to the "agriculture first" theory, which stressed that the quickest way to industralize was to concentrate on agriculture. Equally serious difficulties here led to the recognition that development could only take place if there were an explicit reciprocity between the two sectors.

Regardless of the economic logic of the development plans, in the various countries it became apparent that effective popular support would be crucial to even approaching desired targets. It was found vital, both politically and economically, to minimize urban unemployment and to keep the underemployed in the rural areas. Increasingly, proposals were heard for intermediate technologies and labor-intensive developmental activities in rural areas.

Other major issues covered in the papers included the role of the public sector. Specific attention was given to mobilization of domestic resources, the urgent need for more taxation and greatly improved tax administration, and the ineffectiveness of public administration.

The creation of protected regional markets through the integration of national economies was only mentioned briefly by the contribution in connection with industrialization. This movement offers tremendous economic potential, but presents awkward political problems. The papers commented only tangentially on the importance of the "social" sectors of housing, health, environmental sanitation, and education. Nor did any of them deal specifically with the sectors of economic infrastructure—transportaton, communications, and power. A third area which should have merited considerable discussion is the ever-growing debt-service, attendant repayment difficulties, and probable need for extensive debt renegotiations.

In spite of these omissions, the reviewer found the volume most interesting and quite timely, especially at this juncture of the U.S. foreign aid program. The authors of the papers believe that too much "aid" has been given to subsidize the exports of donor countries or to serve diplomatic, strategic, or military purposes. Too little has been channeled into social and economic assistance.

John Sutton

One Hundred Thousand Tractors

By Robert F. Miller. Harvard University Press, Cambridge, Mass. 02138. 423 pages. 1970. $12.50.

Miller's principal concern in this book is the administration of the machine-tractor stations (MTS) in the Soviet Union. The MTS were the main source of mechanization and a key device for the dissemination of agricultural technology in Soviet collective agriculture from the late 1920's to the late 1950's. The book takes its title from a quote by Lenin in 1917, wherein he expressed his belief that widespread agricultural mechanization in the form of tractors would greatly help in persuading the Russian peasant to accept Communism in the form of collective agriculture.

As it eventually turned out, the tractor was called upon as an emergency measure to bolster agricultural production, which suffered from a catastrophic reduction in the number of draft animals during the collectivization drives of Josef Stalin. Moreover, the MTS became agencies for tight control over agriculture because the collective farms were required to pay the State-controlled MTS in kind for the tillage and harvesting operations performed for them.

Using a broad data base, the author has compiled a concise yet colorful history of the MTS and a detailed account of the evolution of Soviet agricultural administration. The book contains a minimum of statistics, as it is concerned more with political than economic descriptions of the MTS. This is as it should be, since the MTS were both created and liquidated in summary fashion when compared with most of man's administrative mechanisms of 30 years' vintage.

The author demonstrates that ideology can be, in the Soviet Union just as elsewhere, made subservient to practicality when necessitated by crisis. Instances where purely economic considerations have influenced Soviet

policy are amply illustrated, as in the case of Khrushchev's disdain for the MTS as an inefficient supplier of commodities relative to other sources available to the Soviet State. Khrushchev's impatience at the notion of "two bosses on the land" (kolkhoz chairmen and MTS directors) is well documented, and the author's description of events and speeches leading up to the final demise of the MTS is excellent.

Also valuable are the insights gained by the author through interviews with Soviet agricultural specialists familiar with the MTS. Some of these insights no doubt contributed to a description of Khrushchev's later misgivings about his abolition of the MTS. It appears that loss of face may have been the one fear which kept Khrushchev from permitting a regeneration of the MTS in the early 1960's, when the Soviets were experiencing considerable difficulties with inefficiency in mechanized agriculture, and collective farms were disgruntled about having to purchase for cash former MTS machines that they had recently rented for grain.

Miller traces the MTS through evolutionary stages and in so doing demonstrates that such factors as ideology, situational demands, power struggles, and personal leadership style all influenced formulation and implementation of agricultural policy during the MTS period. Moreover, he points out that none of these variables ever operated to the exclusion of the others in the administration of the MTS. Struggles for authority, which characterize all forms of human organization, are documented at both high and low levels of government. Since many early collective farm chairmen were successful party workers from the industrial sector, they resented sharing leadership with the MTS officials. Some of the contests between collective farm and MTS leadership sound remarkably like conflicts between the production and sales personnel of modern American corporations.

Although technical and administrative expertise has always been given at least cursory recognition in Soviet industry, it was not, until the post-MTS period, given sustained credence in Soviet agriculture. The policies of earlier Soviet agriculture have now been replaced with higher prices for commodities and realistic plan targets. Likewise, political coercion and intimidation have been replaced with high premiums for above-plan sales to the State. The implications of these transactions are far reaching, for both the Soviet Union and the world in general. The maturation of Soviet agricultural decision-making as described in Miller's book leaves one with the notion that the USSR's recent agricultural gains are no less a result of cutting red tape than of turning furrows.

This book is not the place to learn the number of tractors in the Soviet Union over time. Rather, it describes the workings of a uniquely Soviet institution which placed an awesome number of machines on the land and helped to revolutionize what had been a backward peasant agriculture. The author has successfully concentrated on the administration of Soviet agriculture and has displayed it in dynamic form, thereby sparing the reader the frequently used exhaustive approach to administrative organizations. It is a work of value to the political scientist, economist, or anyone interested in Soviet affairs.

William H. Ragsdale

Cooperatives and Rural Poverty in the South

By Ray Marshall and Lamond Godwin. The Johns Hopkins Press, Baltimore, Md. 21218. 98 pages. 1971. $6.

This book raises challenging issues about the role of cooperatives in helping low-income (poverty level) rural people to help themselves. The authors show an understanding of the problems, and their treatment of basic issues is both sympathetic and objective.

Probably because of their familiarity with the Southern Federation of Cooperatives, the authors base many of their observations and conclusions on the experiences of the member cooperatives of this federation. This restricts the book's scope more than is indicated in the title. It is about black cooperatives and not primarily, as its title implies, about cooperatives and rural poverty. Actually, there are in total more poor whites than blacks in the South, and the problems and experiences of cooperatives composed primarily of low-income white members are not discussed to any significant extent in this book.

Chapter 1 presents the story of the plight of rural blacks in the South. Perhaps the most significant section in this chapter is a discussion of the future of the Negro in Southern agriculture.

Statements by Theodore W. Schultz and Calvin L. Beale are cited to show that blacks consider agriculture an inferior occupation because it is deeply rooted in the history of slavery and the failure of agricultural institutions to grant them social status, human dignity, civil rights, schooling, and economic opportunity. Schultz seems sure that blacks will abandon the countryside if given a choice. Beale in general agrees, but holds out at least a little hope for the blacks' survival in agriculture.

In chapter 2, the authors talk about conditions for successful development of cooperatives. In addition to the usual conditions, they stress the importance of social

cohesion. They point out that some cooperatives have catered to particular ethnic groups because the inclusion of different groups would prevent unity. While the authors do not specifically say so, they seem to imply this is an important reason for the establishment of many present-day cooperatives on an ethnic basis, particularly among the blacks.

This chapter also contains an enlightening discussion on the surge to "bigness" in farming and its effect on the role of cooperatives. The authors' treatment of the pros and cons is both logical and timely. Relying heavily on international experience as being germane, they conclude that large farms have advantages for some farming activities, but are not technically or economically superior for others. They further conclude that smaller farmers have efficiency advantages in producing labor-intensive crops and can obtain large-scale marketing and purchasing advantages through the formation of cooperatives.

The authors observe that a subsidy to enable these cooperatives to function may be an alternative to welfare payments and they say, "in order to be used as an instrument to help the rural poor, it could well be that the cooperative will have to be modified, at least as it has traditionally operated in the United States."

The nature of modification isn't spelled out, but subsidies and a heavy dosage of outside technical assistance and professional management are implied.

Chapter 3 contains a brief historical look at some of the major attempts to help low-income rural people, particularly blacks, through cooperatives. These efforts began in the 1880's and 1890's with the Farmers Alliance in Texas, a white organization. Affiliated with this was the Colored Farmers Alliance and Cooperative Union (CFACU). CFACU promoted poor people's cooperatives and, at its peak, claimed more than 1 million members.

By 1891, CFACU was out of existence. Its demise was attributed to racial discord, engaging in politics (on the losing side), and such business reasons as undercapitalization, overexpansion, and poor management.

In this chapter, the authors also touch on New Deal efforts to help low-income rural people through cooperatives, particularly the activities of the Farm Security Administration (FSA). From 1937 to June 1946, FSA was responsible for the formation of 25,543 poor people's cooperatives. Cooperative grants and loan funds were made available to lease land; to establish buying and marketing associations; to purchase farm machinery, breeding stock, veterinary services, and insurance; and to obtain water and other facilities.

The smaller and more informal associations had a rather high failure rate due to lack of patronage and management difficulties. The authors conclude, however, that the rate of failure was no greater than that of proprietary manufacturing enterprises during the same period. By the end of June 1946, 84 percent of the 25,543 cooperatives were still operating. Sixty-three percent had completely paid off loans obtained from FSA. Many cooperatives operating today were begun during this period with FSA funds.

The authors observe: "Opposition from the agricultural establishment (the USDA extension service, state extension services, state land grant agricultural colleges, county agents, southern congressmen, private farm machinery and supply companies, established cooperatives, and especially the American Farm Bureau Federation), which considered the New Deal antipoverty programs a threat to their economic and political power base, caused congressional opposition to the FSA, leading to a series of crippling restrictions beginning in 1943. In 1946 the FSA was replaced by the Farmers Home Administration (FHA)."

Chapter 4 is primarily a description and a brief for the Federation of Southern Cooperatives (FSC). FSC was organized in February 1967 and was composed principally of black cooperatives. It was established by representatives of 22 low-income cooperatives, most of which were affiliated with the Southern Cooperative Development Program. Since its formation, the membership of FSC has increased considerably; it had over 100 members in 1971.

Some of the more widely known cooperatives making up the membership of FSC are:

South West Alabama Farmers Cooperative Association (SWAFCA), Selma, Ala.

Grand Marie Vegetable Producers Cooperative, Inc., Sunset, La.

West Batesville Farmers Cooperative (WBFC), Panola County, Miss.

Mid-South Oil Consumers Cooperative (MSOCC), Whiteville, Tenn.

The Poor People's Corporation (PPC), Jackson, Miss.

Freedom Quilting Bee (FQB), Gee's Bend, Ala.

Acadian Delight Bakery, Lake Charles, La.

South East Alabama Self-Help Association (SEASHA), Tuskegee, Ala.

In the final chapter, the authors get back to the very difficult question of whether cooperatives can help low-income people, black or white. On this the authors seem undecided. For example, at one point in the book the idea that blacks will desert agriculture for the cities is given considerable support. If this were to happen, cooperatives would not be able to make any significant contribution to blacks in the rural areas because there would be few left to use the cooperatives.

In the concluding paragraph of chapter 2, a statement is made that: "In general the American cooperative movement has had very little to offer the poor farmer with inadequate incomes and assets." The authors, after considerable wavering on cooperatives as tools to development, conclude they can help:

If cooperatives can become productive and efficient enough to compete with other types of business firms.

If cooperatives can acquire the necessary financial resources.

If cooperative members can adapt to modern technology.

If cooperatives can acquire efficient management and advanced technology.

The authors leave us with the statement that "cooperatives hope to become developmental but it is too early to say with much confidence that they will."

Job K. Savage

Change in Rural Appalachia

Edited by John D. Photiadis and Harry K. Schwarzweller. University of Pennsylvania Press, Philadelphia, Pa. 19104. 265 pages. 1970. $15.

People in Appalachia and the Cooperative Extension Service each have problems adjusting to change. This book dwells on building a better world for both. In a collection of conference papers and journal articles, the editors plus four other sociologists, two educators, and a psychologist, all associated through the Appalachian Center of West Virginia University, tackle the knotty problems of the Southern Appalachians and how Extension might adapt to meet them.

Emphasis on "the individual's adjustment to the new society" is the unifying objective proposed for Extension. The relation of change to the "individual's internal world and his long-term happiness" should be the key concern. Such guideposts suggest the need for a radically revamped Extension Service that has jumped clean over the farm fence. Agriculture may remain a specialty of the organization, but implicit at least in Photiadis' vision is a universitywide service tapping many disciplines and remolding its personnel accordingly.

A sample problem which should concern Extension in the Southern Appalachians—and by inference in other underdeveloped regions and countries—might be how to smooth the path of rural migrants to urban areas. Another is how to reduce the alienation and resignation the poor feel because of the gap between their expectations from life in the larger society and their actual accomplishments. In another example it is suggested that Extension might through appropriate testing predict potential high school dropouts. Having determined who these might be, Extension would then have to organize them in groups and somehow reduce their potential to drop out. This example illustrates the new disciplines Extension would need to tap, as well as the possible competition or duplication in service it might create—in this instance, with the education establishment.

Photiadis defends such new ventures on the grounds that where there is a vacuum, "Extension has the first right to walk in." One can agree that a vacuum should be filled and that Extension has as much right to do so as any public or private group, providing it can effectively deliver the goods. Therein, of course, lies the challenge, since many of the services envisioned to be needed by "individuals adjusting to society" are not in the traditional Extension warehouse of expertise. However, the vision is imaginative and quite possibly essential to the survival of the Cooperative Extension Service. A number of States already have moved out in new nonagricultural directions.

A substantial portion of the book sets the stage for the above new game plan for Extension. A number of excellent chapters cite the impacts of change in the greater society on individuals and social institutions in rural Appalachia. The family, church, local government, education, folk subcultures, and the economy are all treated separately. Some chapters read well, while others struck this economist reviewer as having been composed too much in the verbal thickets of academia.

For the diligent reader, the book presents a wide background on the adjustment pains of rural Appalachia. Robert W. Miller does a good job of assessing retraining and related manpower programs. Nathan L. Gerrard presents a lucid picture of the church in the mountains. Two interesting case studies of power structure conflicts in local communities due to forces of change are provided by Richard A. Ball.

Due to its subject, an essentially tragic undertone pervades the book which lends urgency to the suggested new role for the Cooperative Extension Service. Janice Holt Giles is quoted in part as follows: "Whether these changes will create a happier, more truly abundant life for Appalachia remains to be seen. For a long time they had something very beautiful and something intrinsically very valuable. They were a beautiful people." While this quote might be discounted for overlooking many aspects of life, it does reflect the damage done to the life-style of the people by the loss of their economic underpinning. A major question in our ecology-minded society is how to preserve variety not only in the natural but

also in the cultural environment. The book says folk subcultures are victims of progress. The message is that Extension should do much more to lighten the burdens of mass change.

Theodore E. Fuller

Suburban Land Conversion in the United States: An Economic and Governmental Process

By Marion Clawson. Published for Resources for the Future, Inc., by The Johns Hopkins Press, Baltimore, Md. 21218. 406 pages. 1971. $12.50.

The time has long passed when the subject of land use could be considered purely academic. Fortunately, this book, while meeting scholarly standards for analytical capability and coverage of the subject, is also extremely readable. It should appeal to a broad spectrum of knowledgeable readers who are concerned with today's problems of city, suburbs, and open space. Few readers, perhaps, will be willing to read the book from beginning to end. For this reason, the somewhat unusual repetition of data and ideas in various sections of the book is less objectionable. The repetition is largely unavoidable, given the complexity of the subject and the lack of any generally accepted conceptual and data framework. The book consists of passing a broad collection of relevant data, public knowledge, private observation, research findings, generalities, and suggestions over a series of conceptual screens to classify the various components of a system and winnow out any whole grain that may be there. It is a credit to the author that he was able to develop so much substance out of such a nebulous data base.

Part I, consisting of eight chapters, gives some historic background and introduces the data problems that are dealt with more fully in part II. It describes the participants in the decisionmaking process and their activities as home buyers, builders, planners, developers, governmental units, and others. It brings out the generally independent actions of these participants in what might seem to be a fruitful area for closer cooperation.

Gaps in the data base used in measuring actual land use and changes in land use led to a study of the adequacy of present definitions and data sources which, by itself, would warrant a substantial volume. The five chapters of part II examine the Northeastern Urban Complex of the United States and provide more detail for some of the generalities presented in part I. Two of these chapters give highlights of case studies made by Resources for the Future of three standard metropolitan statistical areas (SMSA's)—Washington, D.C., Wilmington, Del., and Springfield, Mass. A more rapid coverage was given New York, Boston, Philadelphia, and Baltimore. As Clawson makes clear, data from the population and agricultural censuses fall far short of meeting analytical needs. In 1961, for instance, about 21 percent of the land in the Boston-to-Washington Northeastern Urban Complex was in urban and public uses, 35 percent was in farms, and 44 percent was unaccounted for. Much of the idle land and even some farmland fell within largely urban counties. It is just this unutilized land that is the subject of this book. This data gap points to the need for a land use census with a broader base than the current agricultural census.

While much of the author's analysis relates to land use, it is clear throughout the book that Clawson is primarily concerned with the process of conversion of land to urban uses and its effect on people. He points out that decisionmaking is badly fractionated, due to overlapping political and quasi-political taxing and zoning units that generally weaken or emasculate long-run regional planning processes. He indicates that the profit motive in the present institutional framework is only partially successful in promoting land use conversion at a cost and in a sequence that is most productive of the public good. He gives a number of illustrations of public decisions, such as the tax benefits from depreciation allowances and capital gains, that appear to favor speculation rather than development, and the creation of private investment values rather than the public good. Zoning exceptions provide windfall gains to developers who capitalize on public investments in roads, sewers, and water systems. The final purchaser may even pay twice for the public services that provide much of the site value of developable land—once in the inflated value of the land and a second time through taxes on the higher land values.

By careful choice of statistical data, Clawson brings out the comparatively low density of population in many areas that are classed as urban for census purposes. He continually emphasizes the need to examine urban concentration at a less-than-county level. The census count of people according to governmental jurisdictions is inadequate for land use analysis. A census based on relationships of land and people is needed. Clawson's analysis shows up the quick analyst who relies on easily obtained statistics that are ill defined and not comparable over time or space. It is evident to moderately knowledgeable observers that the Northeast Urban Complex, the so-called megalopolis of the North Atlantic Seaboard, is anything but one vast urban conglomera-

tion. Clawson points out that it is not closely integrated socially or economically, and that the interspersed unused land makes it highly unlikely that the megalopolis of the popular writers will occur in this century.

Part III, in about 60 pages, summarizes some of the findings of part II, projects some trends into the future, and examines possible modifications of the urbanization process. While Clawson is far from complacent about the present or foreseeable future regarding suburban land use, he does not regard radical change as either imperative or imminent. He does feel, however, that greater economic efficiency and greater equity could result from certain significant changes in the process. He hints at alternate institutional structures for promoting long-term efficiencies and flexibilities in land use adjustments. Sometimes he provides more than hints, as when he proposes selling rezoning by competitive bidding.

This book is valuable, not so much for new ideas presented or even for a new approach, but rather for its comprehensiveness and readability. Those familiar with the field of land use planning will recognize that once-radical points of view are now stated in matter-of-fact ways, and are related to each other in a more-or-less integrated system.

Our social and economic values are tied much more firmly than we commonly recognize to land-people concentrations. It may be an indictment of our system that something as important to the social and economic structure and the development of our communities has been left so much to chance, without a rational attempt to understand what was happening. Clawson's work has done much to bring order out of chaos and to point out areas where we can improve both our knowledge and our expectations. This book, which appears long and broadly inclusive, is still notable for that which was omitted—a bibliography. Although the author acknowledges a long list of experts in the field and footnotes additional sources, a bibliography, however incomplete, would have been of considerable value.

Howard A. Osborn

Dimensions of Change

By Don Fabun. The Macmillan Company, 60 Fifth Avenue, New York, N.Y. 10011. 230 pages. 1971. $8.50.

Since the dimensions of global communities are changing at a rapid rate, there is widespread speculation on what the world will be like by the end of the century. To be sure, no one can know what will happen in the future, but men can rationally forecast potential developments. In this regard, one can find much of interest in this book.

The author speculates on the changes that technology might bring about in the next 30 years. The book is attractive, illustrated in glossy color. It covers a wide spectrum of areas such as ecology, shelter, energy, food, mobility, and telecommunications.

A dismal assessment is made of the future prospects for ecology, if the deleterious influences on our environment are permitted to continue as they have been in the past. The great historical phenomenon—the Industrial Revolution—which has given the world enormous material wealth, has also given the world pollution. Pollution is disruptive to the environment because its ingredients cannot be incorporated and reused within the system. To avert a crisis, the author suggests the appointment of a Secretary of Ecology at the cabinet level.

Housing needs in the next 30 years will be drastically unfulfilled unless radical innovations in housing structures are accomplished. Shelter must be understood to be part of a dynamic system and not a static phenomenon. Accordingly, the author's position is at variance with the thinking of contemporary urban planners. He contends that cities cannot be "planned" but must develop naturally.

One can look ahead with optimism to an improved society with the use of still untapped sources of energy. Solar energy can supply in 2 days enough energy to outlast all remaining fossil fuel reserves. Nuclear energy can supply as much as half of all U.S. electrical power by the end of the century. Even wind and tidal power can be harnessed effectively to produce electricity without pollution. By the year 2000, power will be used at a rate of five times that being consumed today.

The development of food technology is fascinating reading. In addition to the feasibility of perfecting oilseed and synthetic proteins as reserves against possible food shortages, the author describes novel ideas on raising animals and fish. Game ranches could be set up to raise animals in their native surroundings for cultivation as food, as well as sea ranches which would use killer whales to corral and herd other whales that could be used as food and oil.

As mobility becomes an even more common phenomenon in the American society, alternative modes of transportation must be perfected to substitute for the polluting gas engine automobile. The steam and electric cars will doubtless make their appearance soon, as well as a rapid transit using magnetic trains. The author, however, feels that much of the travel that now takes place will be unnecessary.

Innovations in the field of telecommunication appear to be somewhat mysterious. The areas of extrasensory perception, learning more about the thinking of animals on spaceships, and body language are, it seems to this reviewer, still in the realm of science-fiction. On the other hand, electronic devices such as kinesthetic cinema, cartridge television, and liquid crystals are just around the corner.

If the prophecies prove correct, one could expect to see great change within the lifetime of most of us.

Jack Ben-Rubin

Thomas Jefferson and American Democracy

Edited by Henry C. Dethloff. D. C. Heath and Company, 125 Spring Street, Lexington, Mass. 02173. 209 pages. 1971. $2.50 (paperback).

Thomas Jefferson, third President of the United States, is often credited with developing the agrarian creed. Some of the selections in this collection give his views on the virtues of agriculture and agrarian democracy.

The Stages of Economic Growth

By W. W. Rostow. Cambridge University Press, 32 East 57th Street, New York, N.Y. 10022. 253 pages. Second edition. 1971. $4.95.

When first published in 1960, this volume had a strong influence on development economics, even though many economists disagreed with Rostow's analysis. The widely read ERS report, *Agriculture and Economic Growth*, written by James P. Cavin and others, owed much to Rostow. This "second edition" is essentially a reprint of the first edition, with an added preface and appendix replying to some of the criticisms of the work.

Plantation in Yankeeland

By Carl R. Woodward. The Pequot Press, Chester, Conn. 06412. 198 pages. 1971. $10.

The author, past president of the University of Rhode Island and an authority on the agricultural history of that State, traces a large plantation from its establishment in 1637 to the present. This plantation, like others in the Narragansett region, was operated by slave labor until the early 1800's. Incidentally, this history makes clear that large-scale agricultural operations are not necessarily successful.

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